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A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

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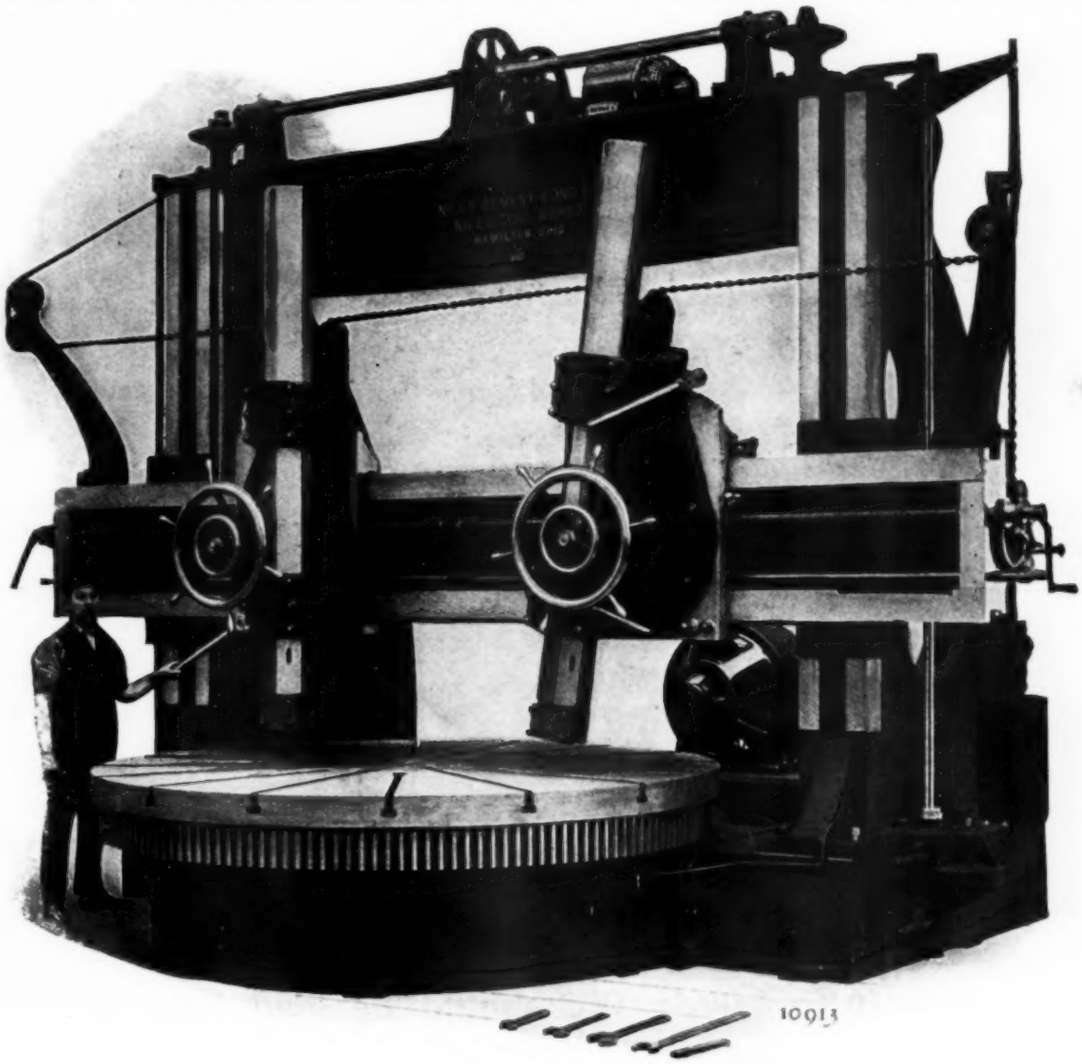


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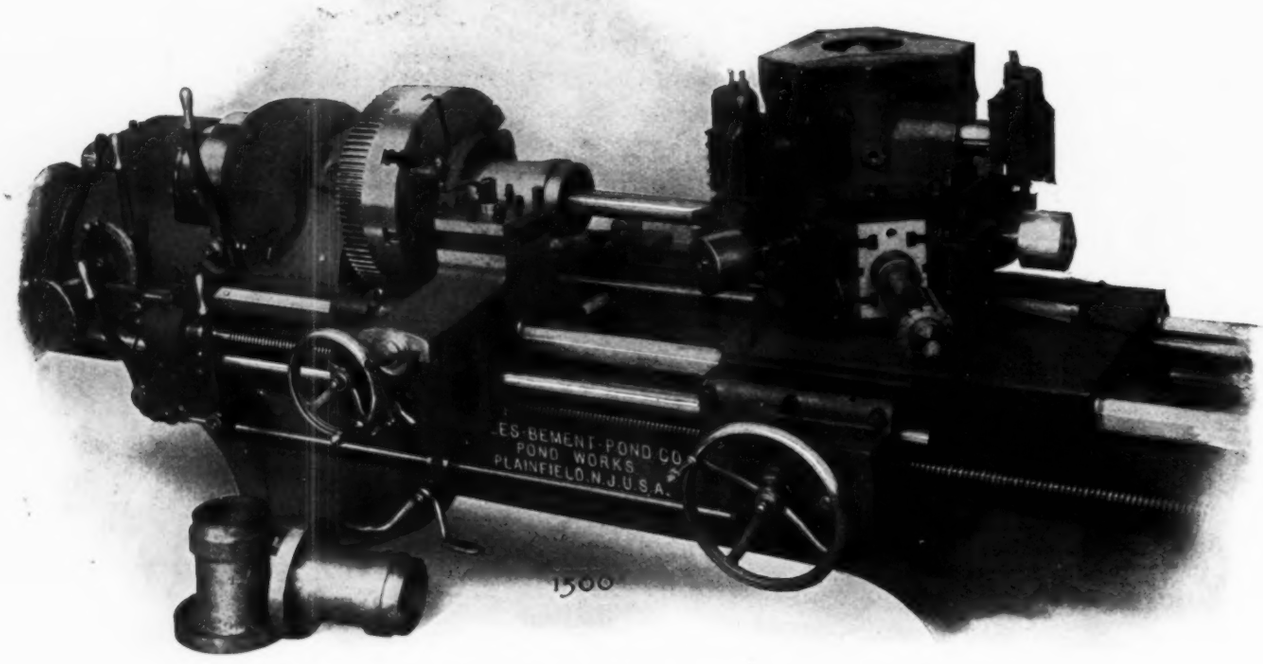


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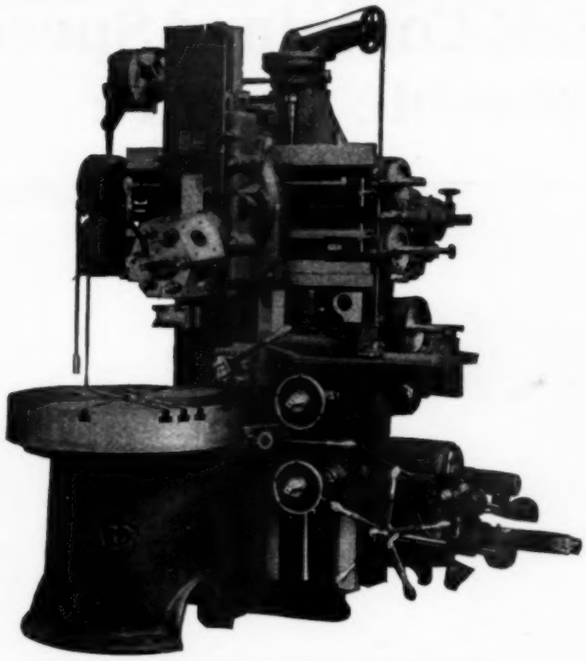

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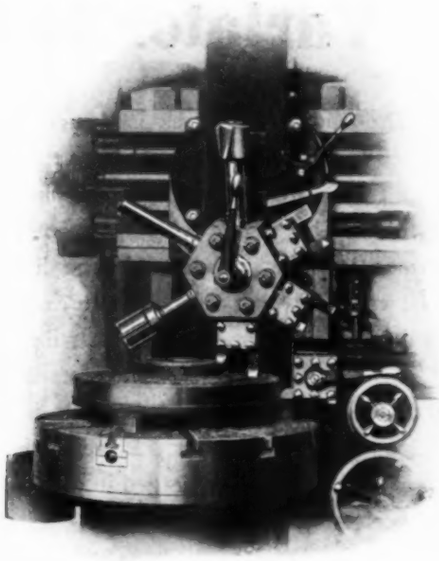

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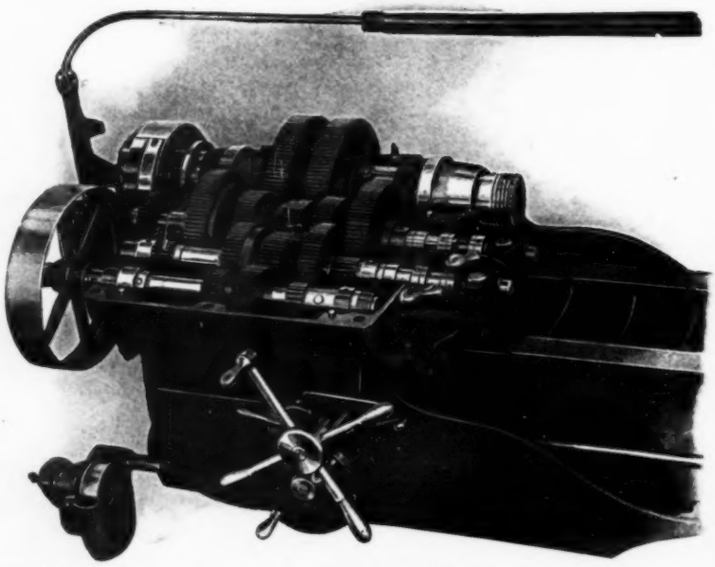

*For more "Flat Turret" details*
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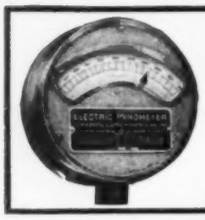

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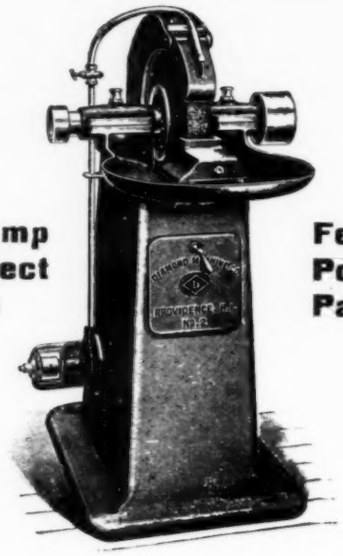

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The water is distributed on the wheel directly in front of the work and is then carried to the column so that it never reaches the spindle boxes. Other Important Features sent on Application.

## DIAMOND MACHINE CO.,

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# Case-Hardening Steel with Gas*

## Some of the Pieces Carbonized with the Depth for Each Hour and the Construction of the Furnace with Its Gas Tank

BY E. F. LAKE

Some good results have been obtained by carbonizing with gas by the American Metal Treatment Company, which is using the special gas carbonizing furnace built by the American Gas Furnace Company, and some pieces are being case-hardened in this machine which it would be very difficult to carbonize by the old method of packing in bone, charcoal, charred leather, or sugar, or the many other materials used for this purpose.

The difficult work done is probably best illustrated by the piece shown in Figs. 1 and 2. This piece has been broken open to show the action of the carbonizing gas on the seven small holes around its rim, and it will be seen by a glance at the halftone that the carbon penetrated to a good depth all around these holes; it being shown at a distance of about 4 inches from the end to the right of Fig. 1 and the top of Fig. 2, which is where it was broken for inspection. It also showed that the carbon had a good even penetration as to depth on all of its exposed surfaces both inside and outside.

Many attempts have been made to carbonize steel with gases in order to do away with the time and trouble of packing them, as well as to eliminate or reduce the cost of the carbonizing materials, but with few exceptions these have been failures.

### Harveyizing

The celebrated "Harveyizing," which is used almost exclusively on armor plate, is one of these. This process uses a bed of charcoal over the work; the plates being pressed up against it in a pit or furnace and gas turned on it so that the steel will be heated through the charcoal, thus allowing the carbon to soak in from the top.

This process has been a great success, but it also has its faults, as the carbon soaks in to a good depth in some places, while at other places, sometimes only a foot away, the carbon will not be so deep, so that when tested a shot will glance off from one spot and when it hits a short distance from this will tear a great hole in the plate.

Then again the Harveyizing process has not been adaptable for small work.

Electricity has also been used in a like manner to the gas in the Harveyizing process. That is, armor plate has been covered with a layer of ground bone, the whole inclosed and a current of electricity turned on to heat the bone and metal so that the carbon will combine with the steel in a surface layer of varying depths, and it is claimed for this process that the depth can be regulated to any depth desired and the carbon is of an even depth over the entire surface.

### Classification of Materials

The materials used in carbonizing might be divided into three classes as follows: First, those which act by means of carbonic oxide such as sugar, animal black (acid cleaned), powdered bone, etc.; second, those which act by means of a cyanide such as cyanide of potassium, bichromate of potash, wood charcoal, etc., and, third, those which act by means of the hydrocarbons, such as illuminating gas, gasolene, naptha, etc.

The first two classes are those which are commonly used for packing the piece to be carbonized in a cast-iron box, so that the carbonizing materials will come in contact with the piece on all sides, and these give the best results, both as to the percentage of carbon and the depth of penetration, according to their ability to form cyanide of ammonium as this is the one and only carbonizing material.

To carbonize with the hydrocarbons, therefore, it is necessary to generate the gases in a tank out of such materials as will form cyanide of ammonium and conduct this to the receptacle in which the work has been placed in such a manner that it will soak into the pieces before passing out of the vent.

Pure carbon does not carbonize in

FIG. 1. CARBONIZED WITH GAS BY THE AMERICAN METAL TREATMENT COMPANY

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vacuum and therefore any material composed of carbon cannot act directly, but acts simply by dissolution of the carbon, starting with the iron in contact with it.

### Metal Used

In carbonizing with gas by this process as well as with all other methods of carbonizing the composition of the steel to be used is of the first importance as the object of carbonizing is to produce a piece that will have a soft, tough core and a hard outer surface or shell that will polish without wear, thus giving it valuable wearing qualities.

As a general rule the steels, whether ordinary carbon or high-grade alloys, that give the best results for annealing, hardening and tempering are not the best for carbonizing, and for this reason special carbonizing steels are made with nearly all of the alloy materials.

The nature of the steel has no influence on the speed of penetration, but has upon the final results obtained.

It is necessary that the carbon content be low in the core; therefore a preference is given to steels containing from 0.12 to 0.15 per cent. of carbon for carbonizing purposes, although some use a steel containing from 0.20 to 0.22 per cent. of carbon, owing to its being more easily machined, but the results are not as good as though the steel contained a maximum of 0.15 per cent. of carbon.

It is also very important that the manganese content of steel to be carbonized be kept low, as manganese has a tendency to render the carbonized surface brittle thus making it liable to chip and break at the least shock. The manganese should never exceed 0.35 per cent., and is usually kept down as low as 0.20 per cent., while 0.25 per cent. is seldom exceeded.

When nickel, chromium, vanadium and other special ingredients are used in steels to be carbonized, these also should have a comparatively small percentage.

### Time of Exposure

The time which the work is submitted to carbonizing is an important factor, as by the regulation of this under a given constant temperature is what gives the depth of carbon desired, and by the proper depth of the carbon is obtained the percentage of carbon desired in the surface layer.

The time of submission required for a certain depth varies with the kind of carbonizing materials as well as with the process used.

The carbonizing materials, such as powdered bone, charcoal, etc., which require that the work be packed in an iron box or other receptacle, take considerable more time to carbonize the work than when gases are used to furnish the carbon, owing to the necessity of the heat penetrating the box and carbonizing materials before it can affect the work.

In case a deep penetration of the carbon is required, and the carbon in the carbonizing materials is nearly or entirely absorbed, it is a difficult operation to insert fresh materials in the packing box.

In the use of hydrocarbons, or gases, a fresh supply can be kept flowing into the carbonizing receptacle and the time greatly reduced for deep penetration with an appreciable reduction of time for the shallow penetrations.

As an illustration of this, the American Metal Treatment Company has obtained a depth of carbonizing of 1/64 inch in one hour, and a depth of ¼ inch in 12 hours.

FIG. 2. ANOTHER VIEW OF THE PIECE SHOWN IN FIG. 1

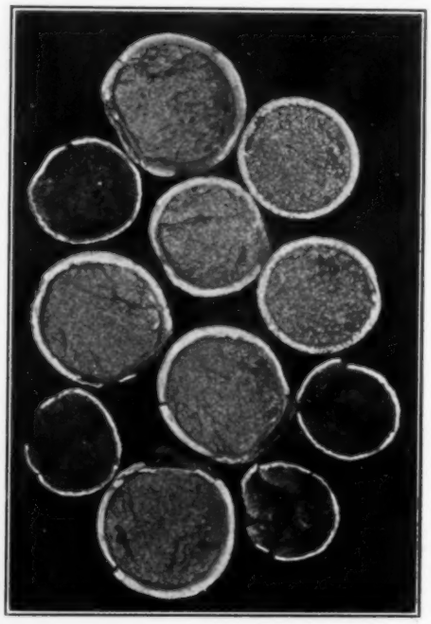


FIG. 3. CARBONIZED WROUGHT IRON AND STEEL

As the work is made to revolve in the furnace, similar to the action obtained by a tumbling barrel, an even depth of carbon is obtained on all sides of the work and the carbon penetrates holes, such as are shown in the piece in Figs. 1 and 2, with a great deal better results.

### Some Results of Time

The results of different lengths of time that the work is submitted to carbonization in this gas furnace is shown in Figs. 3, 4, 5 and 6.

In Fig. 3 is shown some wrought-iron and steel pieces which have been carbonized and then broken open to show the grain and the depth the carbon has penetrated.

The distinct line between the carbonized shell and the core is obtained by plunging the metal directly from the carbonizing furnace into a quenching bath.

By Fig. 4 is shown the depth of the carbonized shell that is obtained in this furnace by carbonizing for 4, 8, 10, 12, 14 and 16 hours and then quenching in a lard-oil bath directly from the furnace.

The same pieces of steel are shown in Fig. 5, but these have been annealed after being photographed as shown in Fig. 4 and then hardened. It will be noticed that in Fig. 5 the lines between the carbonized shells and the cores are not as distinct,

or in other words that the high percentage of carbon in the outer shell dies away gradually into the core.

The test bars shown in Figs. 4 and 5 were 5/8 inch in diameter and are reproduced here at about their actual size.

### Treatment After Carbonizing

The heat treatment of the pieces after carbonizing is very important, if a soft, tough core and a hard non-brittle, wear-resisting outer shell is to be the final result, as it should be to obtain the best results from carbonizing.

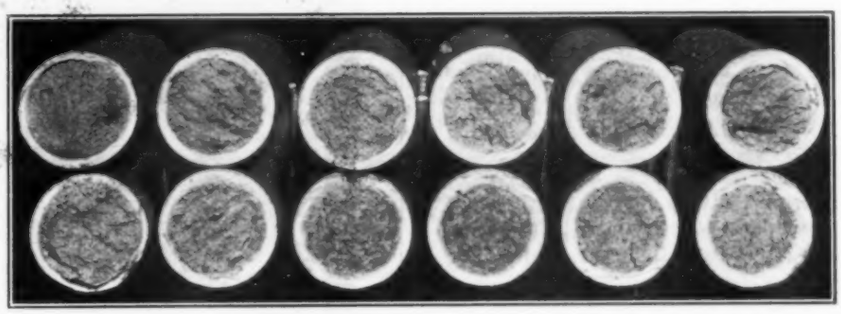
As a general rule all pieces should be annealed after carbonizing in order to destroy any crystallization which might be in the core from the carbonizing temperature and thus cause brittleness. This can be done by heating the work a little above the point of transformation, which in ordinary carbon steel is about 1625 degrees, Fahrenheit, and then cooling slowly.

This, however, leaves the carbonated surface layer too soft to resist wear so that the work should be again heated to about 1400 degrees Fahrenheit and then quenched.

Some ingredients of the high-grade alloy steels alter this point of transformation or the recalescent point so that it varies some 200 degrees and the exact temperature of this point should be ascertained before annealing, as if the pieces are heated much about the recalescent point the metal is liable to be burnt and if not heated to it the transformation in the steel will not take place and the internal strain or crystallization will not be removed.

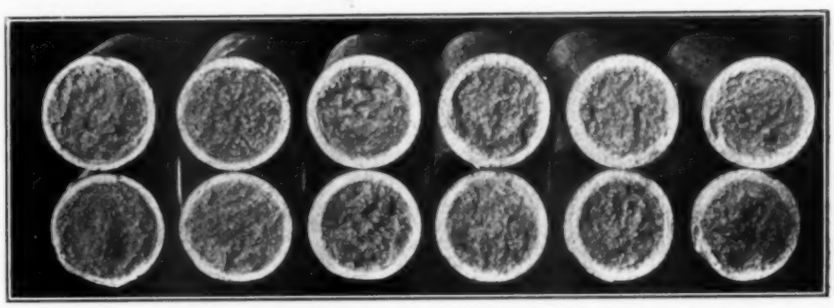
By quenching directly from the carbonizing retort a distinct line is formed between the high-carbon outer shell and the low-carbon cone and this is liable to cause the metal to crack on this line when the work is used for parts similar to rollers in roller bearings, owing to the wearing and crushing strains to which they are

| Time. | Size of Test Piece. | Depth in Inches. |
|---|---|---|
| 1 | 3/8 in. round. | .015 |
| 2 | 3/8 in. round. | .020 |
| 3 | 3/8 in. round. | .030 |
| 4 | 3/8 in. round. | .038 |
| 5 | 1/2 in. round. | .046 |
| 6 | 1/2 in. round. | .053 |
| 7 | 1/2 in. round. | .056 |
| 8 | 1/2 in. round. | .058 |
| 9 | 1/2 in. round. | .060 |
| [illegible] | 1/2 in. round. | .063 |
| 9 | 3/8 in. square. | .075 |



4 Hours. 8 Hours. 10 Hours. 12 Hours. 14 Hours. 16 Hours.
Time for Carbonizing

FIG. 4. QUENCHED DIRECTLY FROM THE CARBONIZING FURNACE



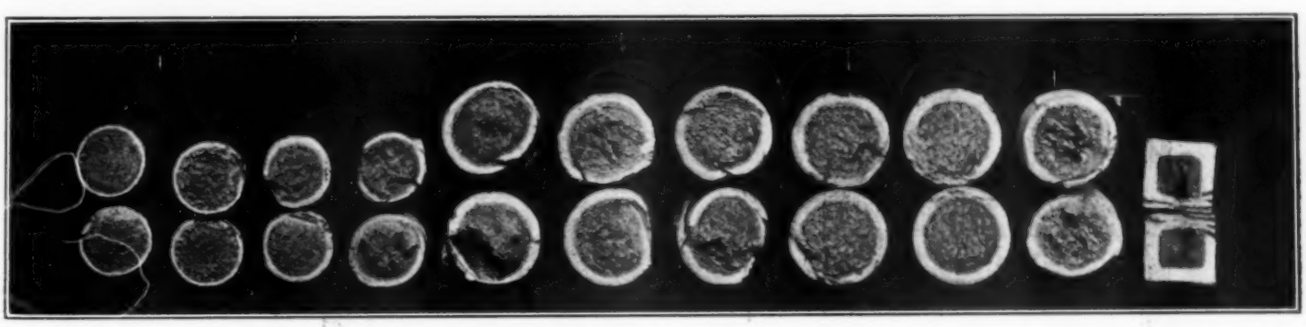
4 Hours. 8 Hours. 10 Hours. 12 Hours. 14 Hours 16 Hours.
Time for Carbonizing

FIG. 5. ANNEALED AFTER CARBONIZING, THEN HARDENED

### Temperature of Work

As the temperature of the furnace has a great influence on the rate of penetration it is necessary that the temperature penetration, but the temperature cannot be raised above a certain point without the metal becoming liable to crystallize, thus making the core brittle.

As a general rule the ordinary carbonizing steels cannot be raised above 1600 degrees Fahrenheit and if the original carbon content is high even this temperature cannot be attained. Thus for this class of work the temperature is usually kept at about 1500 degrees Fahrenheit. The carbon begins to penetrate the



1 Hour 2 Hours 3 Hours 4 Hours 5 Hours 6 Hours 7 Hours 8 Hours 9 Hours 9 Hours 9 Hours

FIG. 6. PENETRATION OF CARBON EACH HOUR FROM ONE TO NINE

submitted, but if the work is properly heat treated after carbonizing, this distinct line is made to disappear, as shown in Fig. 5, and the danger of the steels cracking there is removed.

The set of test pieces in Fig. 6 shows the depth of penetration for each hour from 1 to 9 inclusive as follows:

be kept at a definite point, but as this point varies with the different alloyed steels it is essential that the correct point for each grade of steel be ascertained before starting the carbonizing operations.

The higher the temperature can be raised the deeper will the carbon penetrate and the higher will be the rate of steel at about 1300 degrees Fahrenheit and the temperature should never be raised over 1700 degrees for the ordinary steels and then only when the original carbon content is low.

With some of the high-grade alloyed steels the temperature can be raised much above this with good results, as for in-

stance the nickel-chrome steels will stand a temperature of 2000 degrees Fahrenheit for four hours or more and in fact the best results are obtained in carbonizing these at this temperature, while the tungsten steels may be raised to a temperature of 2200 or 2300 degrees Fahrenheit without any damaging effects.

### Design of Furnace

A very important factor in carbonizing with gas is the furnace, as on the design and operation of this to a large extent depends the success or failure of the process.

In Fig. 7 is seen a drawing on the center line of the furnace for carbonizing with gas, which is built by the American Gas Furnace Company, of Elizabeth, N. J., which holds patents covering it, while Figs. 8 and 9 show a front and rear view of the same.

In Fig. 7, *A* is the retort in which the work is placed. This is made out of extra heavy 8-inch pipe for the size of furnace shown and is made to revolve on the rollers *B* by the gear wheel *C* and the worm *D*, which in turn is propelled by the sprocket wheel shown in Fig. 9, which is connected to the line shaft by a chain. *E E* are air compartments to prevent the heat and work from getting into that part of the retort which extends beyond the heating furnace; *F* is the heating-gas chamber, the gas coming in through 5 openings or burners similar to the one shown at *G* and exhausting out through others; *H* is the cover for the end of the retort and is fastened on with hinged bolts and thumb screws. This is taken off, the partition *I* and carbonizing gas outlet *J* coming with it, in order to put the work in the retort.

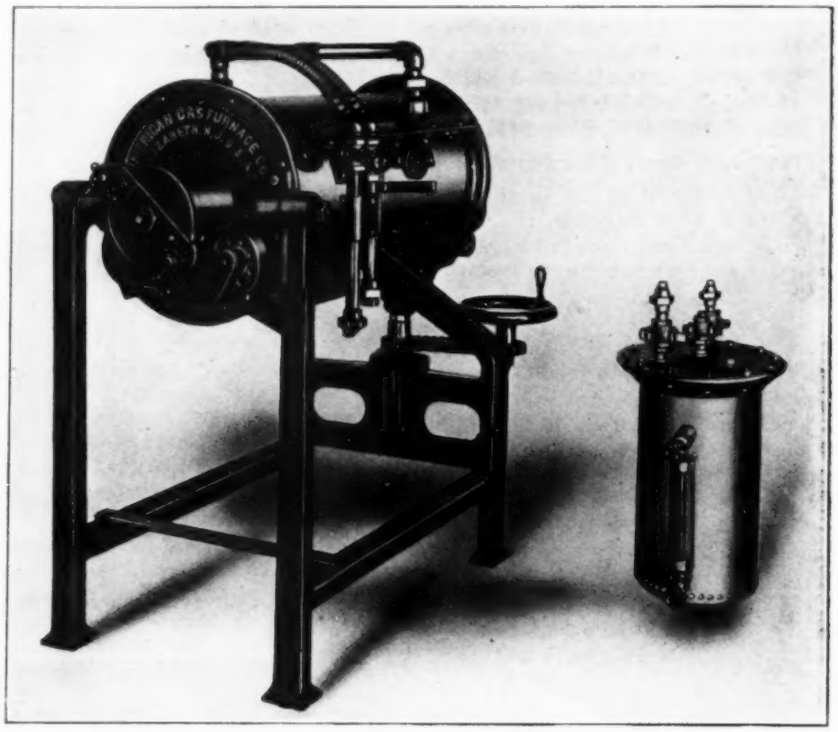


FIG. 8. FRONT VIEW OF CARBONIZING FURNACE WITH GAS TANK

The furnace is hinged at *K* and tilted by raising the back end with the handwheel, sprocket and chain, as shown in Fig. 9. When raised and the cover removed from the front of the retort the work will slide out and drop into a quenching bath, if desired, which can be placed under the machine.

### Operation of Furnace

The heating gas is fed through pipes and burners on the side and the carbonizing gas passes through the hose shown in Fig. 9 and the pipe in the center of the retort at *L*, Fig. 7, then into that part of

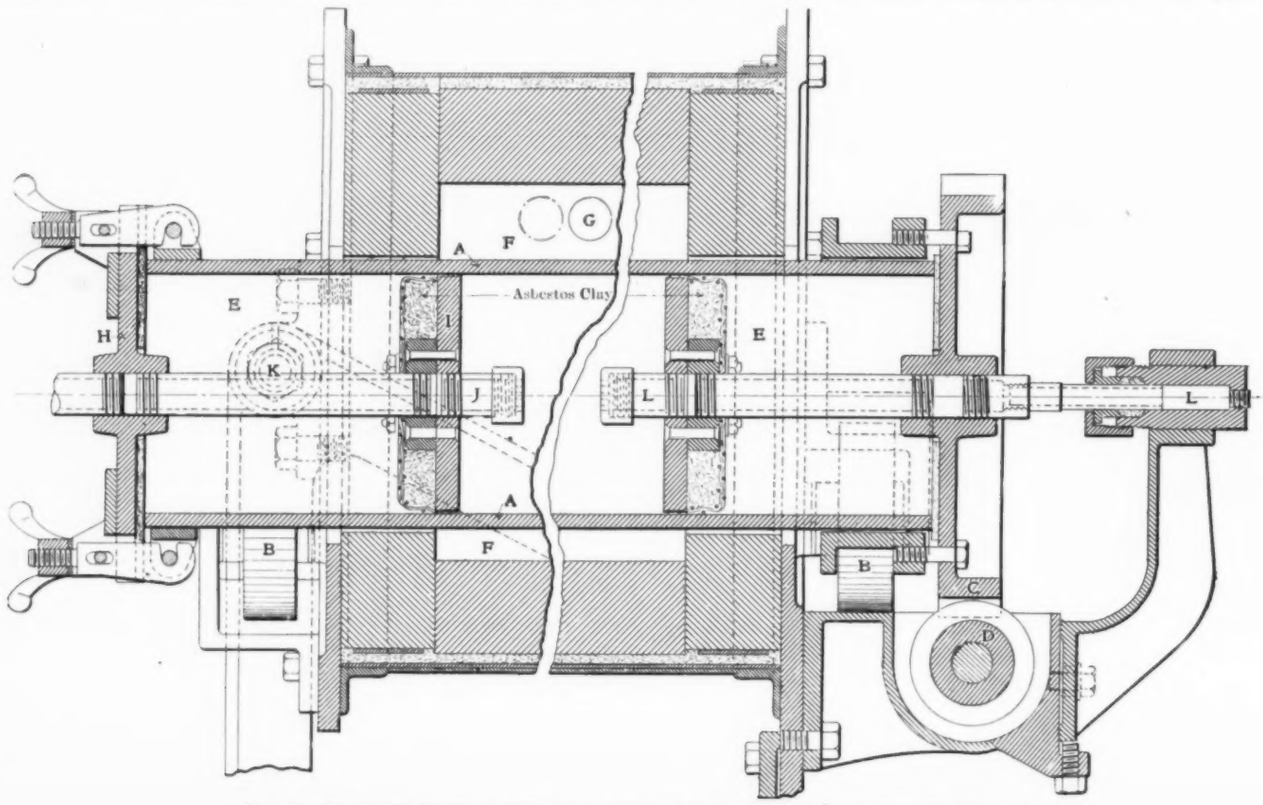



FIG. 7. SECTIONAL VIEW OF AMERICAN GAS FURNACE COMPANY'S CARBONIZING FURNACE

the retort where the work is held. After the carbon has penetrated the metal the gas escapes through the outlet *J*.

This method of operating has many advantages over that of packing the materials in an iron box with bone, charcoal, etc., as the carbon in the retort is held constant by the steady flow of the gas; the work can be inspected for heat temperature by shutting off the carbonizing gas and looking through the outlet pipe *J*, where the work can be seen and its color noted; the carbonizing gas does not need to be turned on and used until the work has attained a temperature that will absorb the carbon and it can be shut off the minute the pieces to be carbonized have attained the proper depth of carbonization.

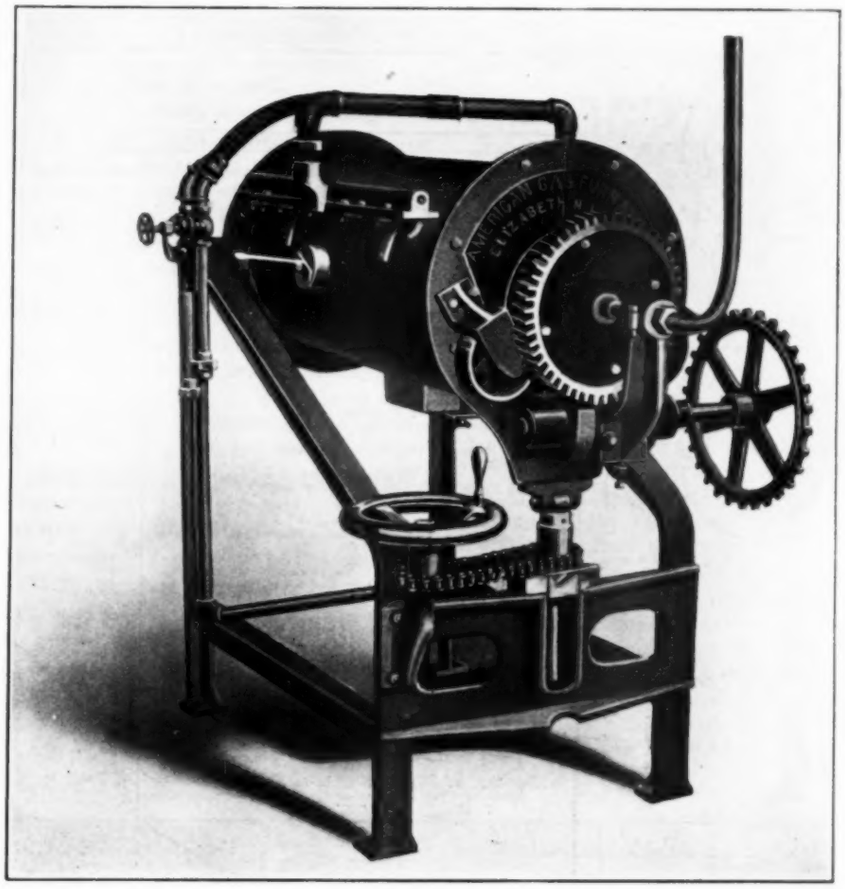


FIG. 9. REAR VIEW SHOWING REVOLVING AND TILTING MECHANISM

The carbonizing gases are formed of liquids which are put into a generator similar to that shown in Fig. 8.

These liquids and their mixture are held a secret by the American Gas Furnace Company, but they are not expensive and can be purchased everywhere. The user of the furnace is at liberty to purchase his own liquids, but is sworn to hold this a secret when purchasing the furnace. The gases are of such a nature that the work leaves the furnace perfectly clean.

Starting with a cold furnace in the morning, an hour and a half is usually required to get the work hot enough to absorb the carbon, after which 40 minutes is required to attain the proper temperature when new work is put in the retort. As no packing of the metal and materials in iron boxes is required, this effects a great saving in time and the gas furnace company guarantees that work can be carbonized for one-half of what it costs by the old method.

### Gaging the Temperature

Pyrometers can be attached to the furnace to gage the heat for the correct temperatures, and when this has been attained the valves and cocks can be set so that the work can be duplicated for any number of times and the furnace run for a long period with an assurance of the quality of the work turned out, as the temperature is held constant.

The design of the furnace is such that when a retort burns out it can be replaced by a piece of ordinary pipe of the right diameter and length and the connections at each end put on easily. The retort, however, lasts for a long time, as it only scales from the heat on the outside and can be used until it burns clear through, the running parts on the retort being at each end, where they are removed from the effects of the heat. This makes it much cheaper than packing boxes in this regard.

The work being made to revolve in the retort, it gives the carbon a chance to soak into it on all sides and this overcomes, to a large extent, the tendency of carbonized pieces to have hard and soft spots, as the soft spots are usually caused by the piece coming in contact with something which would not allow the carbon to act on that spot.

### Odd-shaped Pieces

Intricate or peculiar-shaped pieces which would not turn over in the furnace, but would slide around on the bottom, would have very little carbon on the side, which remained in contact with the retort, and for these it would be necessary to put something inside of the furnace so constructed that it would cause them to turn over. Delicate pieces which would be liable to break would also have to have some special apparatus inside of the retort to protect them.

For the purpose of handling this class of work, as well as doing work for those who do not have enough work to pay for installing their own apparatus, the American Metal Treatment Company, of Elizabeth, N. J., was organized with a corps of experienced men to carbonize, heat-treat and color metals in any way desired.

## A Method of Laying Underground Rails

When laying an underground tramroad or railway it is exceedingly difficult in the semi-darkness of the mine, with the ordinary bridge rail laid on the sleepers with a butt joint, to secure its proper alinement, and considerable care has to be exercised in getting an even joint, which is necessary if a car is to run over it without any chance of its being derailed. It frequently happens that the spikes split the sleeper, allowing a rail to get loose and out of place, and the adjacent rails, remaining rigid, produces a projection against the wheels of the cars as they pass along, causing them to get off the rails and dislocate the traffic until the defect has been remedied.

To prevent this derailment by constructing rails at their ends in such a manner as will prevent one rail moving from its adjacent rail has been accomplished in several ways, one being as follows: A piece of the arch or top of one end of a bridge rail is cut out so as to form a groove or a gap about one inch long and one-half inch wide, vertically down through the arched portion of the bridge. The opposite end of the rail has a projection formed by cutting away a portion of its end side flanges and welding or squeezing together by suitable means the remaining portion of its side ends to form such projection. When laid in position the projection or tongue of one rail fits in the groove of its adjacent rail, thus forming a smooth and almost rigid joint.

# Machining Cylinders in a Glasgow Shop

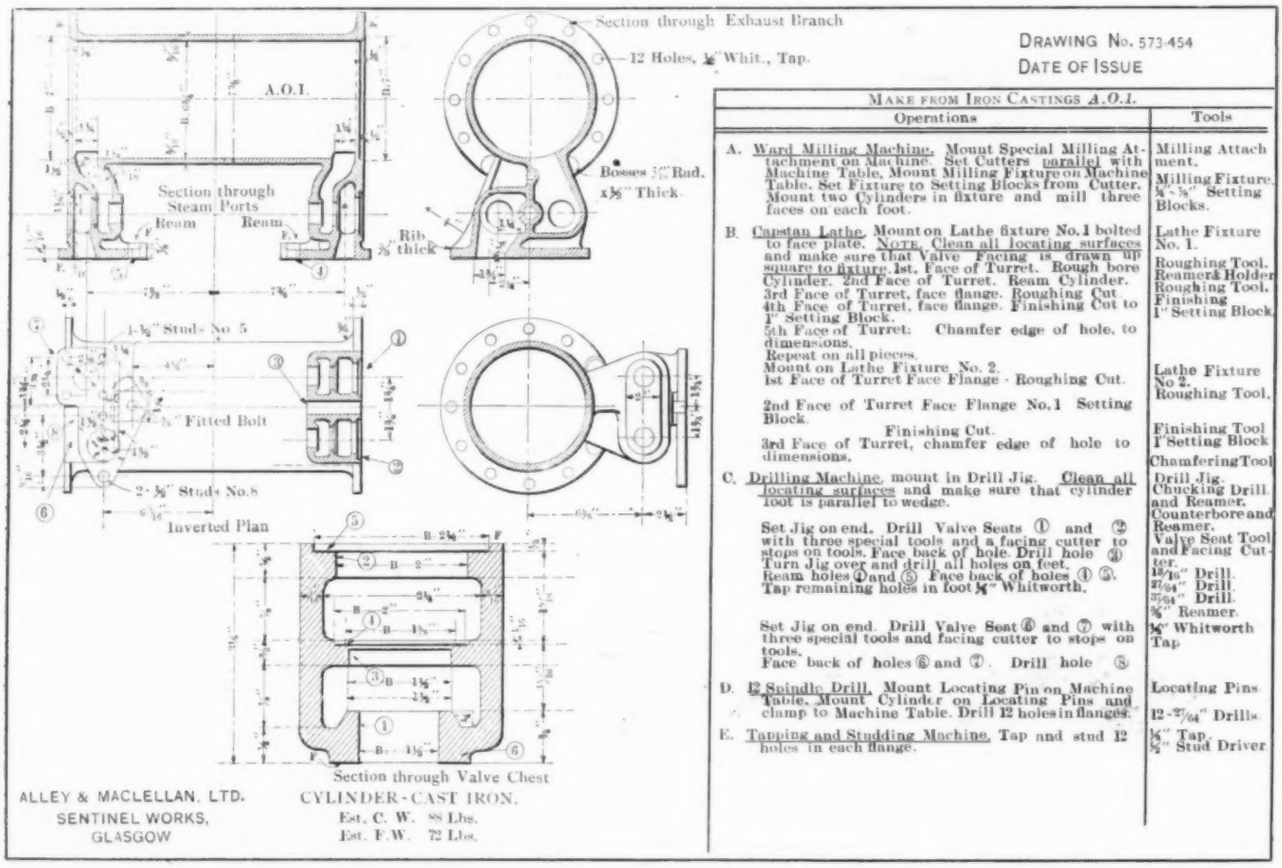
## The Methods and Tools Used by Alley & Maclellan, Ltd., in Making Engines for Heavy Motor Vehicles

BY HENRY MUNRO

The advent of motor vehicles has been a great incentive to the engineering world and has spurred us on to better things. Apart from the fact that it is the only way to manufacture commercially the components of motor vehicles, interchangeability of parts is demanded by all buyers. Parts damaged must be replaced, and the manufacturer must be in a position to duplicate parts in large quantities and to very fine limits of error. Methods which were formerly known only to optical-instrument makers and a few of the higher class toolmakers all now becoming common practice through the trade. The laying out of operations and the designing of special tools in modern shops has long since passed out of the hands of the workman, or even the shop foreman, into the hands of specialists who are learned in this work. In coöperation with a properly organized tool room they provide means whereby the manufacture of interchangeable parts becomes not only possible but highly profitable.

The old terms of "fitter" and "mechanic," as applied to the workmen in the shops, has passed away, and the more appropriate terms, "operator" and "assembler" are used, being symbolical of the work they do. Each man has to specialize in some particular branch of the trade, specialization being the spirit of the age. The introduction of high-speed steel has smartened things up a bit but still it is not the solution of the problem of cost reduction. After you have speeded up your machines to what is called high-speed practice and have been troubled with hot bearings in consequence, you expect to find a week's work finished in a few days and are disappointed with the results. This brings one face to face with the fact that in medium and light work it is the handling of the piece and not the actual cutting time that brings up the cost of the job. On investigating the matter further, you will be surprised to find that in the average shop on this class of work machines are idle from 20 to 50 per cent. of the working day; this reflects no discredit on the workman, because when the machine is idle he may be having his busiest time. In the case of a drilling machine the workman is setting up the job and decorating it with clamps, bolts, etc. When one figures out the actual cutting time, he finds out, that, after all, the high-speed steel does not take him so far in reducing costs as the vendor of it would try to make him believe.

This brings us to the point of designing jigs and special tools. The piece under consideration is the cylinder for the Sentinel 6-ton motor wagon built by Alley & McLellan, Ltd., Polmadie, Glasgow. Fig. 1 shows the shop drawing of this cylinder, which is 20 inches long by 13½ inches wide, mounted on mill board 22 inches long by 15½ inches wide, which is the standard size for all detail drawings. In a few cases the drawings of large pieces are made 27x20 inches, which is known as double standard. All drawings are filed away in the drawing store, which




MAKE FROM IRON CASTINGS *A.O.I.*

| Operations | Tools |
|---|---|
| A. Ward Milling Machine. Mount Special Milling Attachment on Machine. Set Cutters parallel with Machine Table. Mount Milling Fixture on Machine Table. Set Fixture to Setting Blocks from Cutter. Mount two Cylinders in fixture and mill three faces on each foot. | Milling Attachment. Milling Fixture. ¾-⅛" Setting Blocks. |
| B. Capstan Lathe. Mount on Lathe fixture No. 1 bolted to face plate. NOTE. Clean all locating surfaces and make sure that Valve Facing is drawn up square to fixture. 1st. Face of Turret. Rough bore Cylinder. 2nd Face of Turret. Ream Cylinder. 3rd Face of Turret, face flange. Roughing Cut. 4th Face of Turret, face flange. Finishing Cut to 1" Setting Block. 5th Face of Turret: Chamfer edge of hole, to dimensions. Repeat on all pieces. Mount on Lathe Fixture No. 2. 1st Face of Turret Face Flange - Roughing Cut. 2nd Face of Turret Face Flange No. 1 Setting Block. Finishing Cut. 3rd Face of Turret, chamfer edge of hole to dimensions. | Lathe Fixture No. 1. Roughing Tool. Reamer & Holder Roughing Tool. Finishing 1" Setting Block. Lathe Fixture No 2. Roughing Tool. Finishing Tool 1" Setting Block Chamfering Tool |
| C. Drilling Machine, mount in Drill Jig. Clean all locating surfaces and make sure that cylinder foot is parallel to wedge. Set Jig on end. Drill Valve Seats ① and ② with three special tools and a facing cutter to stops on tools. Face back of hole. Drill hole ④ Turn Jig over and drill all holes on feet. Ream holes ③ and ⑤ Face back of holes ① ②. Tap remaining holes in foot ⅝" Whitworth. Set Jig on end. Drill Valve Seat ⑥ and ⑦ with three special tools and facing cutter to stops on tools. Face back of holes ⑥ and ⑦. Drill hole ⑧ | Drill Jig. Chucking Drill and Reamer. Counterbore and Reamer. Valve Seat Tool and Facing Cutter. 15/16" Drill. 27/64" Drill. 37/64" Drill. ⅝" Reamer. ⅝" Whitworth Tap. |
| D. 12 Spindle Drill. Mount Locating Pin on Machine Table. Mount Cylinder on Locating Pins and clamp to Machine Table. Drill 12 holes in flanges. | Locating Pins. 12-27/64" Drills. |
| E. Tapping and Studding Machine. Tap and stud 12 holes in each flange. | ½" Tap. ½" Stud Driver |

FIG. 1. CYLINDER OPERATION SHEET

is situated in the center of the machine shop.

In the top right-hand corner of the drawing is the drawing number 573-454, 573 being the department number, which is taken from a chart and denotes the department which issues the drawing. This chart also embraces all drawings belonging to the nine departments manufacturing in large quantities and on the interchangeable principle such specialties as air compressors, steering gears, ash hoists, high-speed engines, steam stop and safety valves, etc. It also embraces tools, jigs, special machine tools, plant repairs, etc., and gives to each a number by which it can be traced and cost recorded against the various jobs. The second number, 454, is the drawing number taken consecutively in the ordinary way. The special feature in this shop drawing is the list of operations and tools, which is made out by the tool designer. The drawing is made on rice paper and the list of operations is typed on with carbon paper both top and bottom, printing on both sides of the paper so as to give a letter dense enough to give good results in blue printing. In this way a permanent record of operations is shown.

In the old days when the shop foreman reigned supreme, the question whether the piece had to be turned before it was planed, or planed before it was turned, depended upon whose hands the piece, casting or forging happened to be placed in. If it should be the turner, then the operations would be arranged, either through design or through ignorance as to the work the next department had to put on the piece, so that the turning operation came out as simple as possible, without any regard to the ultimate cost of the job.

The operations are made out so that the piece and the jig receive the minimum amount of handling. All operations are carefully considered; all possible methods of machining the piece are gone into and figured on, if necessary, as to costs; into this matter the tool designer should weave the experience of the shop foremen and in this way enlist their sympathy in the job. The cost of the proposed tools is estimated and divided by one year's production of the piece under consideration, to insure that it is going to pay to make the special tools. This method takes the responsibility off the shop foreman, who is left free to allot the work to the various machines and look after his men.

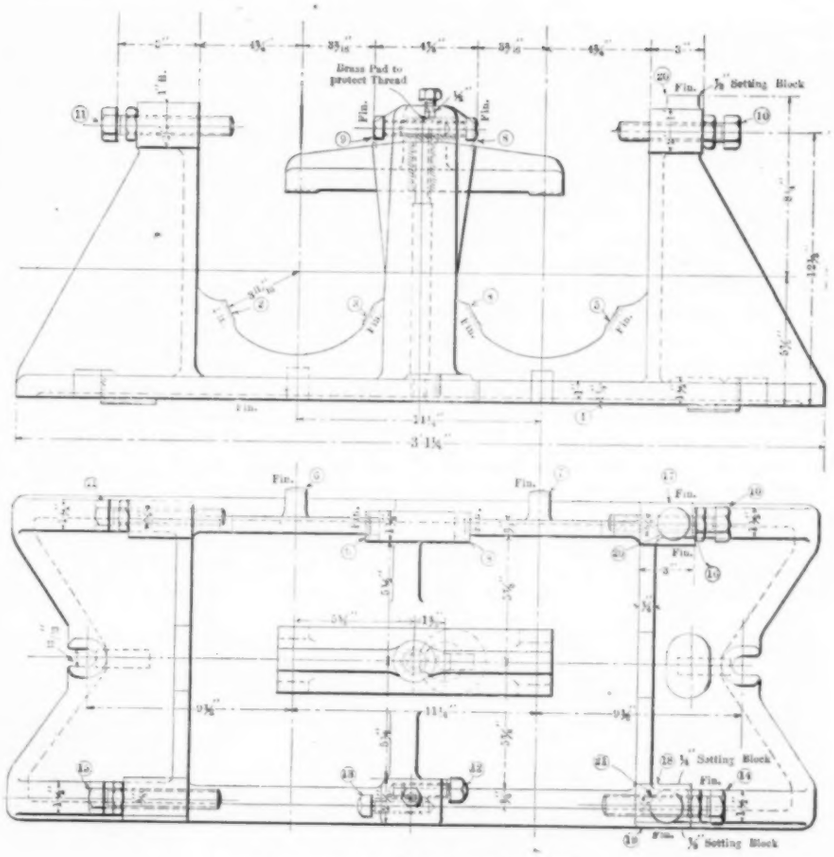



FIG. 4. DETAILS OF MILLING FIXTURE

The foreman receives an order to machine say 24 cylinders, this being the minimum quantity put through to one order. The castings are supplied by the material stores and deposited by the machine at which *A* operation is to be performed, namely, a 24-inch Ward slab milling machine. The drawing is procured from the drawing store and the man started on the job. The workman reads over the instructions referring to the operation which he has to perform and applies to the tool store, when in return for a brass check bearing his number, he is supplied with

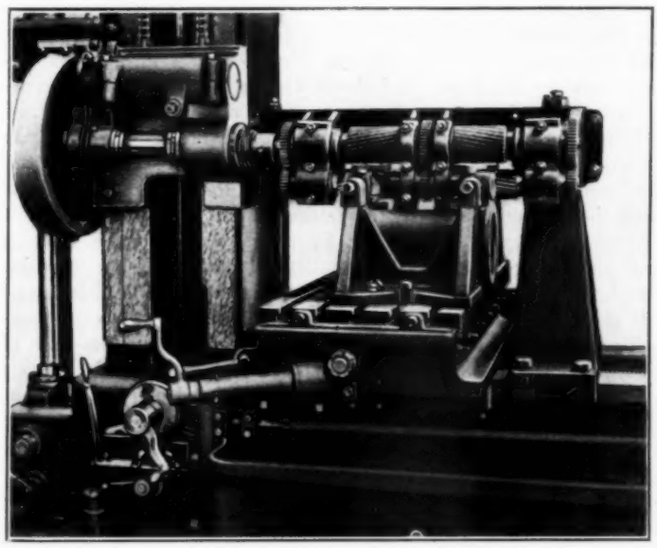


FIG. 2. MULTIPLE MILLING FIXTURE AT WORK

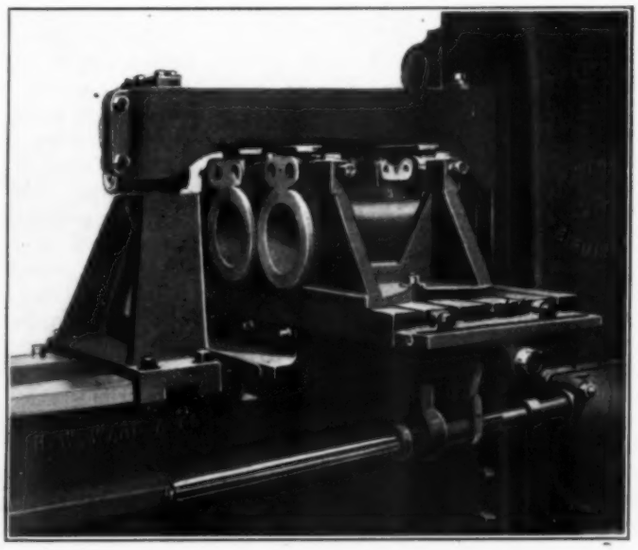


FIG. 3. BACK VIEW OF FIG. 2 SHOWING FIXTURE

the tools necessary for the job, as noted in the column on the right-hand side of the drawing. In this way neither shop foreman, tool foreman nor workman has his memory taxed to remember just what tools are required for the job, which would be a big undertaking in a shop handling so many specialties. It also eliminates unnecessary trips to the tool stores for tools forgotten, which means time and money. When the job is finished, the workman takes the tools back to the tool store, when they are again checked by the list on the drawing, their condition noted and the workman given back his check as clearance for them. Furthermore with this system of shop drawings the usefulness of the foreman or workmen can be judged by their ability to handle the work, and not by their knowledge of shop plant and special tools, because without such a system a man may become indispensable, not because of his ability to handle work or to improve on existing methods, but simply because he happened to be about when certain methods and tools were introduced. A new man in the shop has as good a chance as an old one; he does not require to waste his own time, or that of his foreman or mate, asking questions; all information is on the drawings. The whole effort of the tool designer in this work is to anticipate trouble in the shop, arising from whatever cause, and to give clearly worded instruction on the point; thus trouble saved is money saved.

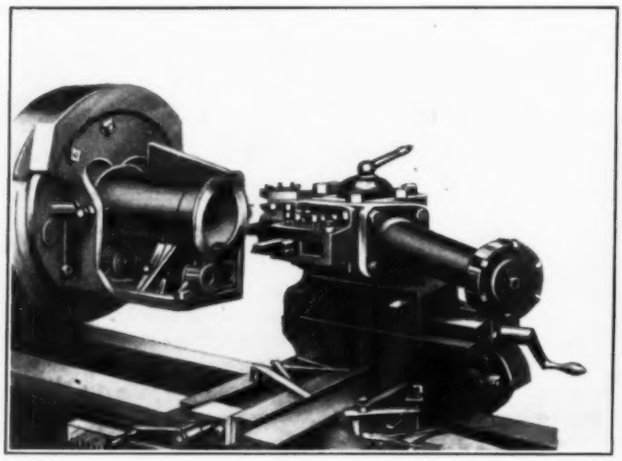


FIG. 5. BORING CYLINDERS ON TURRET LATHE

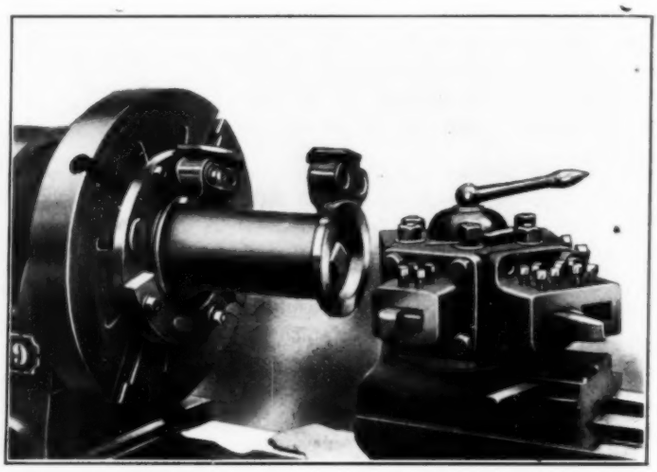


FIG. 6. FACING THE OTHER END

### Operation A—Milling

The first operation on the cylinder is that of milling the three faces on each of the two valve chambers. For this purpose a special milling attachment was designed, Figs. 2 and 3 being a front and back view of it. The 24-inch slab milling machine was specially built for us by H. W. Ward & Co., Birmingham, with a machined face on the housing provided with T-slots for securing attachments of this kind. See Fig. 3. Two cylinders are mounted on a special fixture bolted to the milling-machine table and the three faces of the two valve chambers milled at one cut. Fig. 3 is a back view, with a pair of cylinders finished ready to come off the machine. The milling attachment consists of a heavy gray-iron casting of channel section. The face is machined with strips to fit the T-slots on the housings of the milling machine.

A coupling engages with the spindle, as shown in Fig. 2, which drives the main spindle on which are mounted two 4½x6-inch high-speed steel face milling cutters with right- and left-hand spiral teeth. The spindle is supported on four bearings in bronze bushes which are adjustable for wear, end play being taken up by screwed thrust collars which are split and jammed by means of cheese-headed screws. The other three spindles are mounted on similar bearings and are driven by means of one pair of gears for each spindle, of the required ratio to drive the mills at the correct periphery speed. The gear covers are removed to show the gears. The spindles are of tool steel, hardened and ground; the gears are of mild steel, machine cut. The only adjustment necessary is to compensate for the wear of grinding the milling cutters. This adjustment is obtained by means of two adjusting screws acting between the boss on the main casting, the boss on the supporting bracket and the one engaging with the facing on the housing of the milling machine. The shell end mills are adjusted by packing up on their arbors with ground-steel stock in the ordinary way. The whole attachment can be removed from the machine intact by removing eight bolts, four on the bed plate and four on the housing.

The milling fixture, Fig. 4, which takes two cylinders at a time, consists of a heavy gray-iron casting machined on the base and scraped true to the surface plate, with strips to fit the machine table. The rough casting is heated true to its outside diameter in V's 2, 3, 4, 5. The flange is pushed hard up against stops 6, 7, which locate the end ways. In this position the cylinder is free to turn about the center line of the barrel. The valve chamber is then brought hard up against the stops 8 and 9, which are accurately machined to dimensions from the center line of the cylinder, and set-screws 10 and 11 are tightened up. This locates the valve chamber central with the cylinder barrel. To prevent the possibility of springing the casting adjustable stops are provided at 2 and 3. These are screwed out until they touch the valve chamber, then set-screws 14 and 15 are tightened up and the job is ready for the cut.

The removing of two finished cylinders from the jig and mounting of two more ready for the cut takes 10 minutes. If you compare that with the time of first lining up, marking off and then setting up on the machine table, it can readily be seen how the jig is paid for and the cost of the piece reduced.

On the top of the two end buttresses are two faces 16, 17, 18, 19, accurately machined to dimensions from the center line of the cylinder; they are used in conjunction with distance blocks for setting the milling fixture in relation to the cutters. These setting blocks are of mild steel 1½ inches diameter and of various thicknesses from ⅛ to 1 inch by eighths, and from 1¼ to 2 inches by quarters. They are case-hardened, ground and lapped to size, the limit of error being 0.0001. Two of these are seen on the base of the milling fixture in Fig. 2. The use of the setting blocks is as follows: The milling fixture is bolted to the machine table as already described; the machine table is then adjusted until a ⅞-inch setting block just passes between the machined face 19 on the jig, and the teeth of the shell-end milling cutter. By turning the cutter spindle, adjustment can be made to the highest tooth of the cutter. This setting can then be proved by trying the ⅞-inch setting block on the opposite side at face 17 and also with ¼-inch setting block at faces 16 and 18 to test the inside cutters. This locates the fixture in the desired position and at the same time

checks the setting of the cutters on the arbors relative to one another, so that the chance of error is reduced to a minimum, and the personal element, which is always present when a workman uses the micrometer or vernier gage, is entirely done away with. Further to set the face milling cutters parallel to the machine table and at the required hight from it, faces 20 and 21 are used with ⅛-inch setting blocks.

All this setting requires to be done only once for each time the attachment is mounted. To put the facts in a nutshell: The fixture bears a fixed relation to the machine table and the fixture to the cutters; therefore each cylinder as it is placed in the fixture against the stops bears a fixed relation to the cutters. Further, the cylinder being located from its outside diameter and the valve chest machined relative to the center line, it follows that by locating from the valve chest in operation *B* the cylinder will be bored out as near as possible true to its outside diameter, a very desirable point when the walls of the cylinder are only 5/16 inch thick.

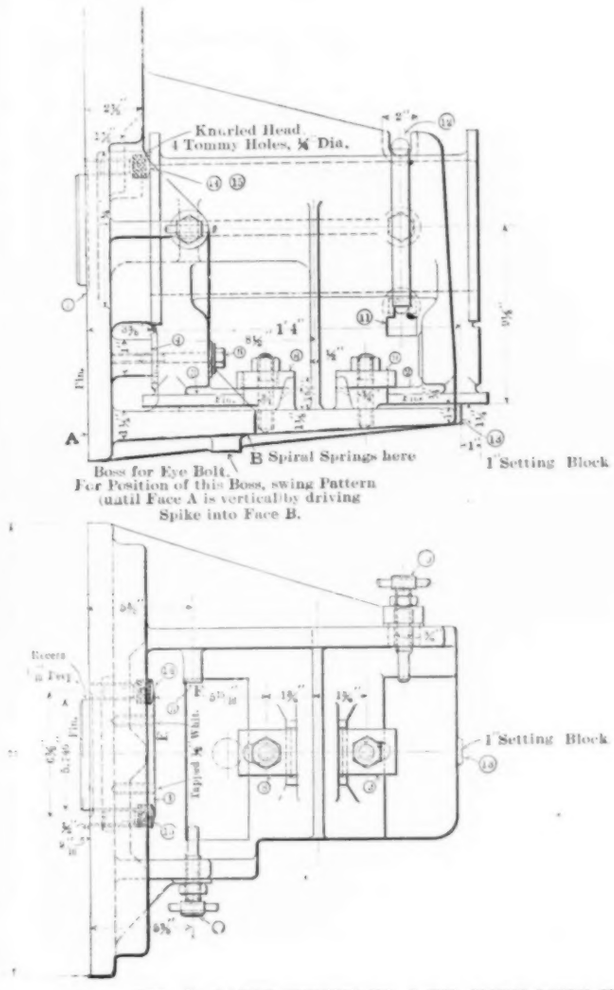

Knurled Head
4 Tommy Holes, ⅜ Dia.
B Spiral Springs here
1 Setting Block
Boss for Eye Bolt.
For Position of this Boss, swing Pattern
(until Face A is vertical) by driving
Spike into Face B.
Tool Steel Strap
Spring Tempered
Note: Bolt Holes drilled
to suit Face Plate
1 Setting Block

FIG. 7. LATHE FIXTURE NO. 1 FOR MOTOR LORRY CYLINDER

### Operation *B* — Boring, Facing and Chamfering

The boring, facing and chamfering are done on a Lang turret lathe, as shown in Figs. 5 and 6. Fig. 5 shows special lathe fixture No. 1 bolted to the face plate of the turret lathe; in the turret can be seen the special heavy rough boring bar and floating-reamer holder. The facing and chamfering tools are in the ordinary tool boxes of the lathe; all the cutting tools and blades of the reamer are of high-speed steel. Fig. 7 is a line drawing of the lathe fixture, which consists of a gray-iron casting. Face 1 is turned with a spigot to fit the hole in the face plate of the lathe; faces 2 and 3 are shaped square to face 1 to dimension from the center line of the lathe spindle. Face 4 is shaped parallel to face 1. Locating stop 5 is machined to dimension from the center line of the cylinder.

To mount the cylinder in the fixture the lathe spindle is turned round until the fixture is in the position shown in Fig. 5. The cylinder is placed in position with the valve chamber down, and pushed against the locating stop 5 by the thumb screw 7, which locates the cylinder central, sideways or on a horizontal center line. The fixture gives the correct hight of center of bore on the vertical center line, as the cylinder has been machined to this dimension in the previous operation. It is drawn up against stop 4 by bolt 6 passed through the cored hole in the valve chamber. The face of the valve chamber, having been machined in the previous operation, squares the cylinder lengthwise or in line with the lathe spindle. The two bridge clamps 8 and 9 are now screwed down, which secures the cylinder to the base of the fixture. Nurled-headed screws 14 and 15 are tightened up to the flange to take the thrust of boring and to prevent springing the fixture. To eliminate the chance of chatter in the front end of the cylinder, the thumb screw is lightly tightened up against the cylinder walls and jammed. Then the flexible-steel band is slipped into T slot 11, passed round the cylinder and through slot hole 12, being drawn up by the nut as shown, securing the front end. Face 13 is accurately machined to dimension from face 4 to receive a 1-inch setting block for setting the tool for the finishing cut across the flange in the same manner as setting the milling cutters.

When the boring, facing and chamfering on one end of the 24 cylinders are finished, No. 1 fixture is removed from the face plate and fixture No. 2 is mounted, as shown in Fig. 6. This fixture is simply a gray-iron face plate turned on the back with a spigot to fit the face plate similar to that on No. 1 fixture. It has a long boss or spindle cast on. This is turned a sliding fit for the bore of the cylinder, which slips over it as shown. A bolt is passed through the cored hole in the valve chamber and draws the cylinder up to the turned flange so as to act as a driver, taking the strain of the turning off the chuck. The front end of the boss is split in six places and a taper plug, mounted on a screw after the manner of an expanding collet chuck, grips the front end of the cylinder securely while the flange is being turned and the bore chamfered. The nut for expanding the chuck can be clearly seen in Fig. 6. In this case the setting block is placed against the nose of the spindle or chuck, which is machined to dimension for this purpose.

OPERATION *C*—DRILLING MACHINE

The next operation is drilling and lapping of all the holes and finishing the valve chambers; for this purpose the jig, Fig. 8, was made. In designing this jig I found that the limit of weight was such that a man could conveniently handle both the jig and the work without the aid of lifting tackle, the use of which always means lost time, looking for help, slings, etc. So I decided to keep the weight down as much as possible and yet have a jig rigid enough to stand up to its work without springing.

The method of locating the work in the jig and the valve-chamber tools may be interesting. Fig. 9 is a line drawing of the drill jig, which is a gray-iron casting of channel section embracing three sides of the cylinder, the overhanging ends being securely braced by two mild-steel stays 1 and 2, into each end of which are screwed special bolts, the heads forming the feet for the jig. This arrangement gives a very strong jig for its weight and is open on three sides. When loading the jig, it is rested on its back at 3 and 4. The cylinder is slipped into position resting on strip 5 and wedges 6 against the stop, which locates the cylinder approximately opposite to the mild-steel locating spigot 7. This is let into the main casting and secured by set-screws as shown. By turning hand screw 8, the cylinder is swung central with the bore and pushed hard up against stop 9, which locates it endwise; in doing this it is lifted bodily 1/32 inch clear of strip 5.

In this position the cylinder is free to turn about its axis true to the bore to the extent of the clearance. Thumb screw 10 (see enlarged view of wedge) is then tightened up and moves the wedge piece 11 up the inclined plane 12, face 13 of the wedge moving parallel with the feet of the jig, 3 and 4, or machine table, which engages with the machined face of the valve chamber and brings it parallel to the feet 3 and 4 into the desired position for drilling. In this manner the cylinder is located in the jig in a very short time and by handling two screws. In fact the time for loading and unloading this jig is 11 minutes.

For machining the valve chambers there are three special tools, shown in detail in Fig. 10. The first tool to the left is the roughing or opening-out tool and consists of a 1 7/64-inch chucking drill 1, the shank of which is held in the body of the chucking drill 2. Reamer 3 finishes the hole after drill 2. The tool is piloted by a hardened-steel bushing in the drill jig by diameter 5.

Referring to Fig. 1, the 1 7/64-inch chucking drill takes out diameter 1, this drill being through the hole before the 2-inch chucking drill begins cutting. The 2-inch chucking drill roughs out diameter 2 and is followed by the reamer. At this part of the operation the tool is supported at both ends; the 1 7/64-inch chucking drill acts as a pilot at the lower end and the body of the tool in the jig bushing. The tool is fed by hand until the hardened-steel stop 4, Fig. 10, strikes the drill bushing. This tool is removed from the drilling-machine spindle and the second tool mounted, as shown in Fig. 8.

FIG. 8. LIGHT MILLING JIG FOR CYLINDERS

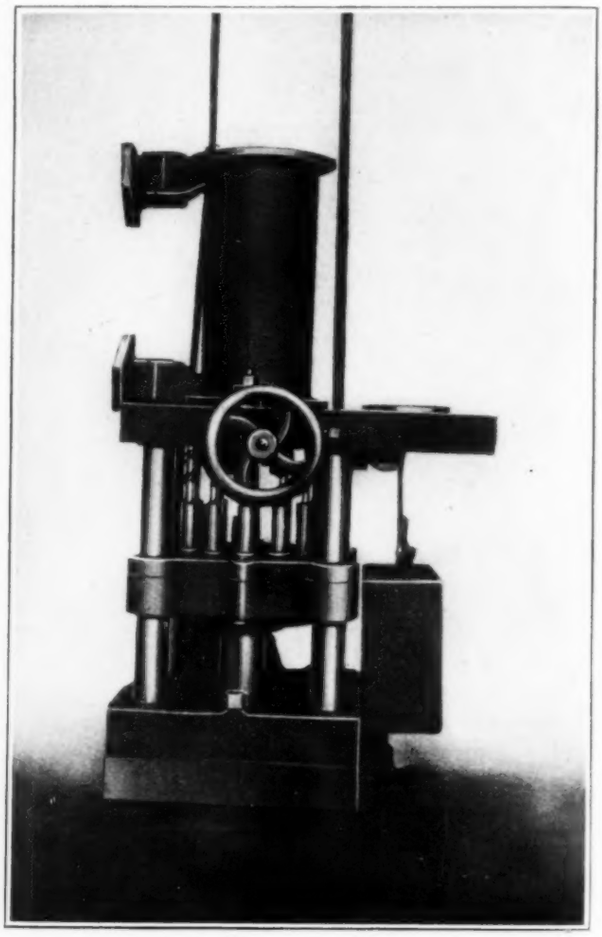


FIG. 11. SPECIAL VERTICAL DRILL WITH DRILLS BELOW WORK

This tool is made in three parts to facilitate grinding. Reamer 6 and pilot 7 are held in the body of the tool at 8 by the set-screw shown. Tools 9, 10 and 11 are end mills, the outside diameter of 11 being ground to take the stop collar 12, which is split and jammed on diameter 11 by the set-screw as shown, after being adjusted to dimension from the face of the cutters.

Again referring to Fig. 1, the 1⅛-inch reamer finishes diameter 1. The reamer goes through the hole and the tool is piloted by diameter 7, Fig. 10, while the 1½-inch end mill is clearing out hole 3. Then the two end mills form a recess at 4 and 5. This tool is fed by hand until

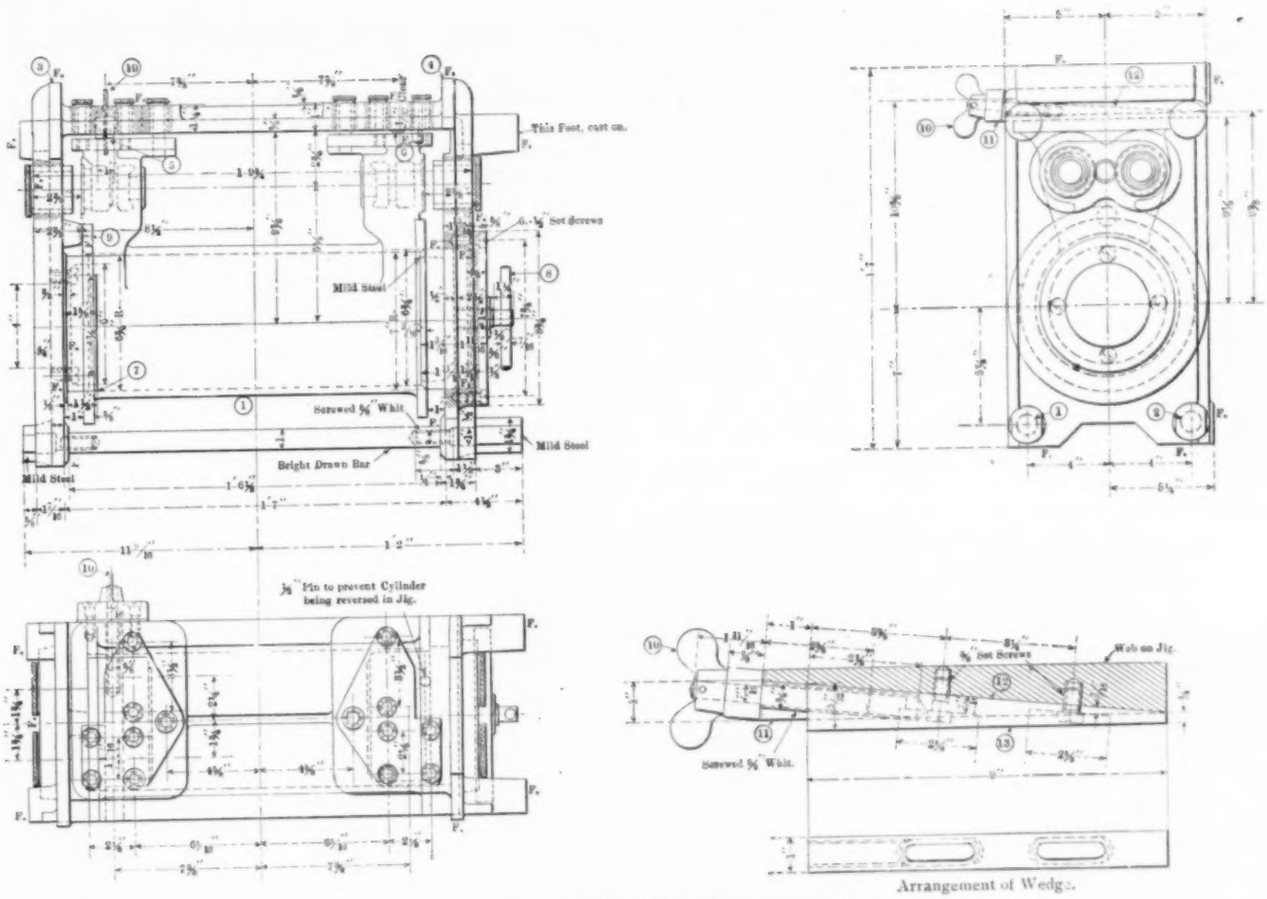



FIG. 9. DRILL JIG FOR MOTOR LORRY CYLINDERS

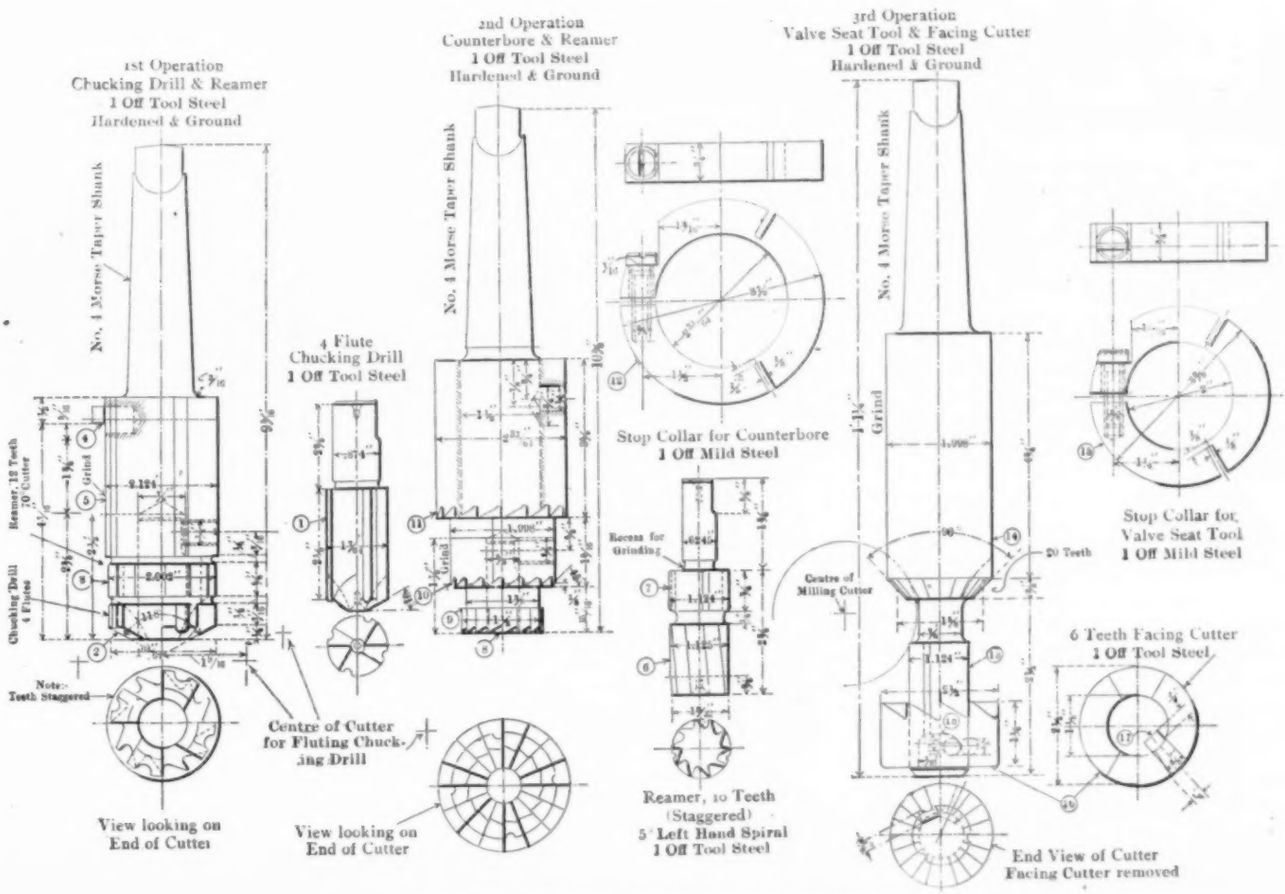



FIG. 10. SPECIAL TOOLS FOR CYLINDER VALVE SHEET

the stop collar strikes the face of the drill jig for depth. This collar stop is adjustable for the wear of the cutters by grinding.

The third tool is for cutting the valve face. It being most important to get the valve face in line with holes 1 and 2, Fig. 1, this tool is piloted from both holes by diameters 13 and 14 and is fed by hand to collar stop 15. It is also important that face 6, Fig. 1, be faced true with holes 1 and 2. After the valve seat has been finished, the facing cutter 16 is mounted on the pilot 13, which projects through hole 1, Fig. 1, and driven by means of pin 17 engaging in slot 18 as shown. This arrangement allows the facing cutter to be mounted and removed very quickly. As a matter of fact, one valve chamber has been finished complete in seven minutes. The other holes are drilled, reamed, or tapped through bushes as shown.

### Operation *D*—12-spindle Drilling Machine

This operation is the drilling of 12 stud holes in the flanges of the cylinder. For this purpose I designed a special 12-spindle drilling machine, Fig. 12, which, like all the tools described in this article, was built in our own tool room. It will be noticed that this machine is of special design and quite different from the ordinary practice in multi-spindle drills.

In designing special tools of this kind all fancy work has to be avoided. That is, everything that is not absolutely essential is avoided and nothing but the bare necessaries is considered. The machine must be up to its work; it must be simple and cheap to make, and it must effect such a saving as to pay for itself in from 6 to 12 months, according to the number of parts that are to be manufactured. There is always an element of risk about making special tools of this kind, as the design of the parts for which the machine is made may be altered; this must be considered along with the cost.

Instead of the drills being fed down vertically or in a horizontal direction, as is customary in this class of machine, they are fed up through the table from below, the drills being guided in hardened-steel bushings let into the table after the manner of the drill jig. The table is kept low for convenience in lifting the cylinders on and off without the use of lifting tackle. The machine is driven from a pulley at the back through a pair of bevel gears at the base of the machine to a vertical splined shaft in the center, passing through the gear box which is seen about midway between the base and the table. This gear box is mounted on four mild-steel columns 2 inches in diameter and is free to slide up and down by means of a lead screw actuated through a worm and worm wheel from the hand wheel shown.

In the inside of the gear box, running in an oil bath, is a gear driven by a feather in the splined vertical shaft already referred to. This gear engages with a gear on each of the 12 spindles, which have No. 2 Morse taper sockets, as shown in Fig. 11. Each spindle is provided with a dust cap to prevent dust getting into the bearings. The back balance weight takes the weight of the gear box off the elevating screw, which feeds the gear box and with it the drills up to the work. The cylinder is dropped onto a spigot which fits the bore and also a pin which fits into one of the valve chambers already drilled and is held down by two straps. Both flanges, being alike, are drilled on this machine as are also the two cylinder covers and the crank chamber.

Operation *E* is the last in the machine shop and consists of the tapping and studding of 12 holes in the flange, which is done in the ordinary way.

## Questions for Shop Men and Managers

By John R. Godfrey

Have you ever noticed any difference in the drilling of cutters whether soda water or lard oil was used as a lubricant? Some of my friends who are using both lubricants find that cutters last longer with lard oil than with soda water, yet on some work, such as a very long pinion, they seem to get better teeth if they use soda water in cutting. The cut is smoother and more satisfactory in every way, but the cutters become dull more quickly than with lard oil. Has this been your experience and what is your explanation of the reason?

### Different Effects of Slack Times

The slacking of trade has brought out several interesting things to consider. In one shop that I know of there has been a falling off in the hourly output per man while in another line of industry I am informed that the amount of work each man does per hour has increased very materially. What is the difference and why?

Is it because in the one case the men are afraid of "working themselves out of a job," or in the second is each trying to prove himself the better man to be more sure of his job? And which is the better attitude for the man, for the employer and for the trade generally?

Closely allied with this is another question which is by no means universally agreed upon. Does a man accomplish as much in a short day as a long one, and which are the most productive hours of the day?

### When Does a Man do the Most Work

It has always seemed that it took a man some little time to get his gait in the morning and after dinner and it seems the most natural thing in the world to ease up a little just before quitting time when a man ought to be more tired than at any other time of the day.

On the other hand, there are practical men, both at the lathe and in charge of shops who tell us that they find the average man does more work during the last two hours of the day, from 4 to 6 in the afternoon, than in any other two hours. Has this been your experience and what are the reasons?

### The Advertising Pages

I should hate to hurt the tender sensibilities of the editors, but it occurs to me that too many of us overlook the fact that the advertising pages are often as interesting as some of the articles that do not happen to be in our particular line. Probably many will brand this in that class.

Now one of the duties of a shop manager or superintendent or foreman is to keep posted on the new tools and processes, and while these are usually mentioned in the reading columns we have to get to the advertising end of the paper to hear the maker's side of the story. True, his claims are sometimes pretty strenuous and are for conditions that do not often exist, but this is being outgrown and he realizes that while claims may sell one machine they will not sell another or it will not stay sold until it makes good.

### A Plan to Keep Tabs on New Tools

Would it not be a good plan to have each foreman report to the superintendent each week, the new tools he has seen advertised that appeal to him as being adapted for his work so that catalogs and other information could be secured even if the purchase of such a machine might be distant or even improbable? They could also report on advertised performance of certain tools when the work was in their line and show how it compared with their own practice.

We all know that much valuable information is to be had from modern catalogs and other trade literature. Why should we not take advantage of the every week announcements of these same firms to keep posted on what they are doing in the way of new machinery? The enterprising firm puts its best foot forward and displays in its catalogs and fliers the latest and most up-to-date pointers in regard to its product. Many of these can be made of direct use in connection with one's own work.

Personally, I get a large amount of information from the advertising pages and I believe it will pay any foreman or workman either, to do this in his own time. I further believe it would pay to set aside an hour each week for the foreman to talk the matter over with the superintendent. I'm not an advertiser and have no ax to grind, but if others get as much information out of the advertising pages as I do, they would take the paper even if it was all advertising, as so many complain about.

# Cam Adjusting on Automatic Screw Machines

## Regulation of the Feeds of Turret and Cross-slide Tools on the Cleveland Automatic Machine by Adjustable Cams

SPECIAL CORRESPONDENCE

The cams on the Cleveland automatic screw machine, made by the Cleveland Automatic Machine Company, Cleveland, Ohio, front and rear views of which are illustrated in Figs. 1 and 2, respectively, may be classed under the following names: Turret cams, feed-regulating cams, cross-slide cams, chuck opening and closing cams, stock-feed cams. These cams are all clearly shown in position, in the half-tone engravings, and are represented also in the drawing, Fig. 3, which is a plan view of the operating mechanism.

### The Turret Cams

The turret cams located just to the rear of the turret, as seen in Fig. 1, are shown at *C* and *D* in the diagram, Fig. 3. These cams are fixed and are never changed. The forward and back movements of the turret *E*, controlled by these cams, are constant for all kinds of work; the idle travel of the turret, before the tools reach the work, is made at high speed, the cutting feed being tripped in just as the tool reaches the point at which it is to start cutting. The feed of the turret to every revolution of the spindle is variable to suit the conditions of each individual tool held in the turret. That is, if there are five cutting tools in the turret and each tool requires a different feed from any of the others, each individual rate of feed is obtainable by means of the adjustable feed-regulating cams.

### Feed-regulating Cams

These cams, as seen in both of the general views, and at *F*, Fig. 3, are strips of flat steel ¼x1 inch, and each cam is held in place by two screws. The cams may be moved across the face of the drum *G*, this movement being provided for by slots milled in the drum, where the screws clamp the cams; also, they may be set at slight angles, taking peculiar staggered positions, as may be seen in the drawing. There are two of the cams for each hole in the turret and the amount of feed per revolution of spindle is controlled by these cams to suit the individual requirements of each tool.

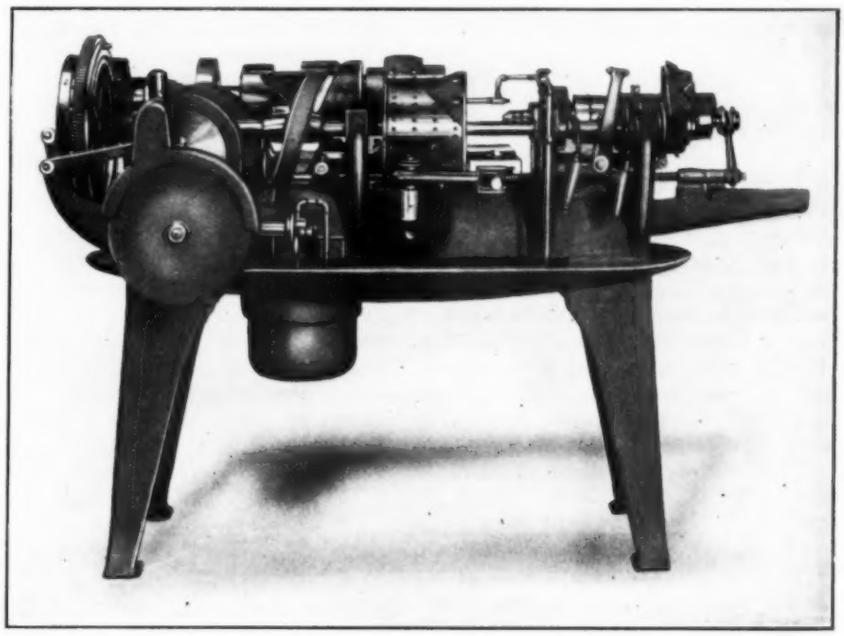


FIG. 2. REAR VIEW, CLEVELAND AUTOMATIC SCREW MACHINE

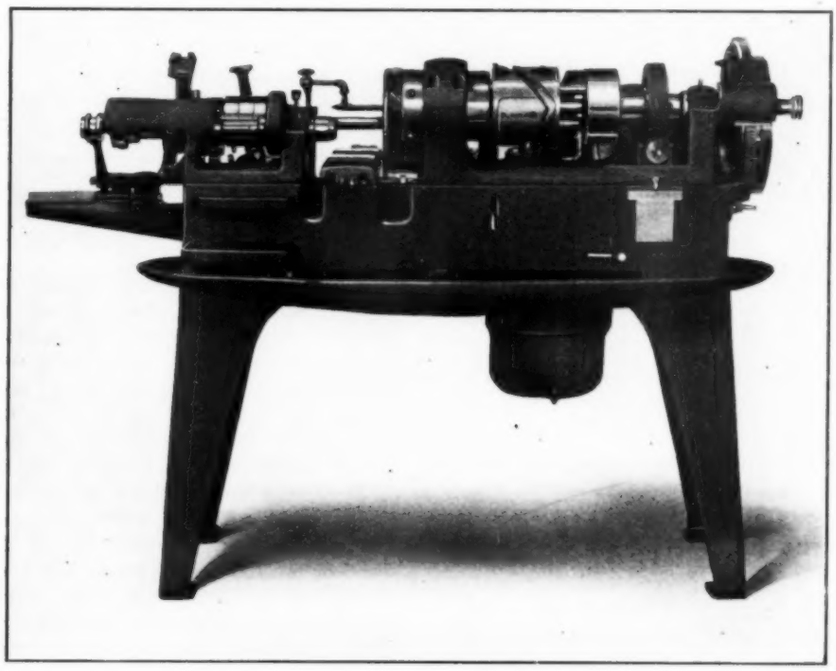


FIG. 1. CLEVELAND AUTOMATIC SCREW MACHINE

In setting these cams the operator watches the cutting tools and adjusts the cams until the tools are removing the desired amount of stock per revolution of spindle. A slight change of angle on any of the cams produces a noticeable difference in the turret feed. The cams act through the medium of the levers *H*, which raise and lower the friction roll *I* between the friction disks and so give the variable feed. The disks are clearly shown in the rear view, Fig. 2, as well as in the drawing just referred to. The cams *F* that are set at an angle, or staggering, as they appear in the drawing, are in most cases intended for carrying the roll from one cam to another; that is, from the cam set back to the one forward, or *vice versa*. There are, however, occasional cases when a cam may be used at an angle, say in drilling certain holes. Thus the drill can start in with the feed decreasing, or increasing, as it advances. When using a drill that is not an oil feed, the lubricant does not reach the cutting edge as the drill ad-

vances; for this reason it may be desirable not to feed the drill so rapidly, and in such instances it is advisable to use the feed-regulating cam set at an angle.

### Cross-slide Cams

The drum *J*, carrying the cross-slide cams, has (as will be noticed in Fig. 2) a number of rows of tapped holes around the periphery. The cams *A* and *B* are standard for all work and are adjustable around the drum. The rate of feed of the cross slide is variable, this also being controlled through the regulation of the cam shaft speed by the feed-regulating cams *F*, in combination with the turret feed. If a forming tool is working in conjunction with a drill, the feed is set for the heaviest cut each tool will stand. If a cut-off tool is working either in conjunction with another tool or individually, the cams that take care of this tool are adjusted without interfering with other tools in the different operations.

### Chuck Opening and Closing Cams

These cams are shown at *K* and are also visible in both half-tone illustrations. As there shown they are cast solid on the face of a segment for bar work, while for magazine and double-camming work a drum is used. For bar work adjustment is unnecessary, as the cams are cast in the correct position to allow ample time for chucking the longest piece within the capacity of the machine.

### Stock-feed Cam

The stock-feed cam *L*, which answers for all work except where double feed is required, is cast to the required shape and clamped to the cam shaft. The general form is well illustrated in the rear view, Fig. 2, where the cam is shown just to the left of the cross-slide drum. Its adjustments are either around the cam shaft or lengthwise upon it.

In case double feed is desired, that is, if it is required to feed the stock twice to one revolution of the cam shaft, a drum is put on the shaft in place of this segment, and two cams, which are cast to the same outline as the segment, are fastened to the drum.

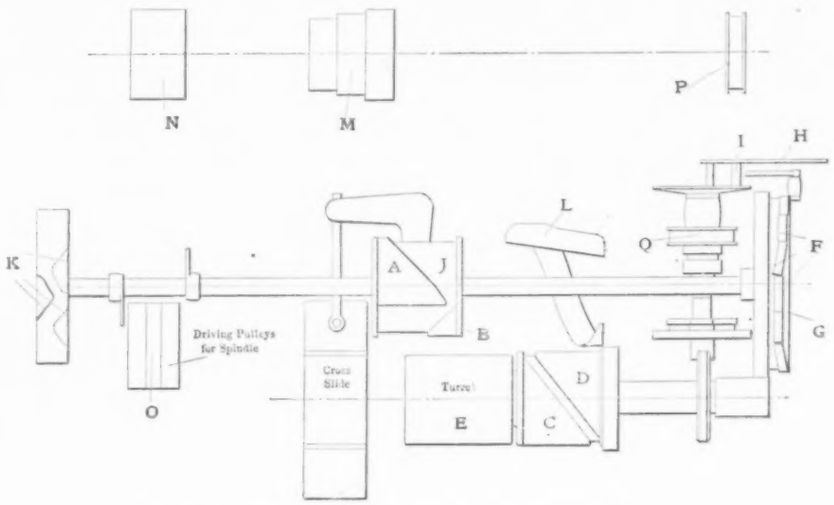



FIG. 3. CAMMING DIAGRAM, CLEVELAND AUTOMATIC

POSITION OF TOOLS AND CAMS ON THE CLEVELAND AUTOMATIC

Sample No. Order No. Mach. No.

| Position of Tools in Turret | | Position of Regulating Cams at R | |
|---|---|---|---|
| 1 | | 1 | |
| | | 2 | |
| 2 | | 3 | |
| | | 4 | |
| 3 | | 5 | |
| | | 6 | |
| 4 | | 7 | |
| | | 8 | |
| 5 | | 9 | |
| | | 10 | |
| 6 | | 11 | |
| | | 12 | |

R Regulating Drum

Position of Cross Slide Cams

| | |
|---|---|
| A | |
| B | |
| C | |
| D | |
| E | |
| F | |
| G | |
| H | |
| I | |
| J | |
| K | |

Cross Slide Drum

Tools on Front of Cross Slide

Tools on Back of Cross Slide

Pieces per Hour

Revolutions of Countershaft per Minute

Size of Flange Pulley

Size of Spindle Pulley

Pins in Regulating Drum outside

Pins in Regulating Drum inside

Remarks:

Extra Tools and Attachments

FIG. 4. SETTING UP CHART FOR CLEVELAND AUTOMATIC (ACTUAL SIZE 6X12 INCHES)

### The Setting-up Form

Fig. 4 illustrates a printed form that accompanies machines that are tooled, and covers all adjustment necessary in doing any class of work. The feed-regulating drum, shown at *G*, Fig. 3, and the cross-slide drum *J* are both represented on this sheet, which is designed to simplify the setting up of the machine when changing from one job to another.

### Speeds, Feeds, etc.

The countershaft diagram is included in the drawing, Fig. 3, *M* being a three-step cone belted from the main line; *N* the drum from which the spindle-operating pulleys *O* are driven; *P* a pulley for driving the feed mechanism through the medium of a quarter-turn belt passing over pulley *Q*.

In setting up a job on the machine, the speed at which the spindle must revolve in order to get the peripheral speed of work best adapted to the tools is the first consideration and is obtained by placing the belt from the line shaft on the most suitable of the three steps of countershaft pulley *M*, giving a fast, medium or slow countershaft speed. As the tool feed is variable between widely separated extremes of feed, the changing of the speed of the countershaft does not affect the feed of the tools, as the feed-regulating cams *F* are adjusted to accommodate the faster or slower speeds of the countershaft and produce the desired rate of feed of the cutting tools per revolution of work.

# Alterations of Steel in Heat Treating

## Some Tabulated and Charted Results of the Expansion and Contraction of Steel with Different Degrees of Temperature in Hardening

BY J. E. STOREY*

Considerable diversity of opinion appears to exist as to the effect of hardening and tempering on the dimensions of steel; if a number of persons were asked whether hardening produced expansion or contraction, their replies would probably be equally divided on the point. There is a great deal more in this question than a casual examination of the subject would suggest. It is of great importance in the making of screw gages, taps, dies, etc.; if it were possible to control the movement of steel introduced by hardening, the greatest difficulty in securing accuracy and interchangeability in the production of screw threads would be abolished. Notwithstanding the amount of attention that is being given at the present time to the heat treatment of steel (four or five papers were presented at the last meeting of the Iron and Steel Institute at Vienna), this phase seems to be sadly neglected. The cause of the movement does not appear ever to have been clearly defined, neither has the relation between the movement and the degree of hardness.

Some time ago I found it necessary to carry out a series of experiments on the effect of the hardening temperature upon the movement introduced by hardening. Incidentally the effect on the shape and size of the article hardened was investigated, and also the results obtained by different quenching baths.

For the experiment a number of test pieces were made, about 4 inches long and ⅞ inch diameter; as the experiment was undertaken preliminary to the hardening of screw gages, the ends of the test pieces were roughly screwed as shown in Fig. 1. The pieces were nicked in the center to facilitate fracturing after hardening; were, as far as possible, made from the same bar of steel in order to obtain similarity in the composition of the steel, and, before hardening, were ground on the outside to facilitate accurate measuring. The process to which they were all subjected consisted of: (1) Measuring at the length *A* and the diameters at *B*, *C*, *D*, and *E* (see Fig. 1); (2) hardening at different temperatures varying from 730 to 890 degrees Centigrade; (3) measuring about 2 hours after hardening, at the same points as (1), and in addition, in the case of diameters, at right angles to the original points; (4) tempering by boiling in oil for about 1 hour at 200 degrees Centigrade; (5) measuring again in the same way as in (3).

The greatest care was taken to prevent errors and to avoid approximation.

| Test Piece No. | Hardening Temp. Deg. Cent. | Length *A* | Diameters. | | | | Mean End Dia. *B* and *E*. | Mean Middle Dia. *C* and *D*. | Mean Dia. *B, C, D, E*. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *B* | *C* | *D* | *E* | | | |
| 8 | 730 | +1.08 | +0.70 | +0.47 | +0.76 | +0.85 | +0.77 | +0.61 | +0.69 |
| 1 | 740 | −0.06 | +0.34 | +0.50 | +1.05 | +0.67 | +0.50 | +0.77 | +0.64 |
| 10 | 760 | +0.56 | +0.86 | +1.16 | +1.08 | +1.19 | +1.02 | +1.12 | +1.07 |
| 2 | 781 | +1.36 | +0.27 | +1.31 | +1.34 | +0.73 | +0.50 | +1.32 | +0.91 |
| 11 | 800 | +1.38 | +2.11 | +2.13 | +1.74 | +1.99 | +2.05 | +1.93 | +1.99 |
| 3 | 825 | +0.59 | +1.22 | +2.41 | +2.07 | +1.67 | +1.44 | +2.24 | +1.84 |
| 12 | 860 | −0.17 | +3.43 | +2.84 | +3.34 | +3.23 | +3.33 | +3.09 | +3.21 |
| 5 | 881 | +0.45 | +2.30 | +3.56 | +2.96 | +2.60 | +2.45 | +3.26 | +2.85 |
| 6 | 890 | +0.12 | +2.61 | +3.46 | +3.38 | +3.18 | +2.89 | +3.42 | +3.15 |

TABLE 1. ALTERATION BY HARDENING. FIG. 1. UNIT = 0.001 INCH.

| Test Piece No. | Hardening Temp. Deg. Cent. | Length *A* | Diameters. | | | | Mean End Dia. *B* and *E*. | Mean Middle Dia. *C* and *D*. | Mean Dia. *B, C, D, E*. |
|---|---|---|---|---|---|---|---|---|---|
| | | | *B* | *C* | *D* | *E* | | | |
| 8 | 730 | −1.59 | −0.03 | +0.34 | +0.69 | +0.15 | +0.06 | +0.51 | 0.29 |
| 1 | 740 | −3.13 | −0.48 | +0.68 | +0.80 | −0.18 | −0.33 | +0.74 | 0.20 |
| 10 | 760 | −1.79 | +0.32 | +1.05 | +0.64 | +0.71 | +0.51 | +0.84 | 0.68 |
| 2 | 781 | −1.67 | −0.94 | +0.73 | +0.54 | −0.82 | −0.88 | +0.63 | −0.12 |
| 11 | 800 | −1.70 | +1.22 | +1.96 | +1.33 | +1.22 | +1.22 | +1.64 | 1.43 |
| 3 | 825 | −5.61 | −0.38 | +1.66 | +1.41 | −0.13 | −0.25 | +1.53 | 0.64 |
| 12 | 860 | −7.95 | +2.04 | +2.59 | +2.87 | +1.80 | +1.92 | +2.73 | +2.32 |
| 5 | 881 | −8.26 | +0.77 | +2.62 | +2.27 | +0.91 | +0.84 | +2.44 | 1.64 |
| 6 | 890 | −10.80 | +0.41 | +2.21 | +2.40 | +1.03 | +0.72 | +2.30 | 1.51 |

TABLE 2. ALTERATION AFTER TEMPERING. FIG. 1. UNIT = 0.001 INCH.

The list above shows that each piece was subjected to 23 measurements. All measurements were carefully taken on a Newall measuring machine to 1/100,000 inch, so that the errors introduced by faulty measuring would be extremely small.

### Apparatus Used in Tests

The hardening furnace used was a Brayshaw salt-bath furnace, and the temperature was measured by a Whipple electrical resistance pyrometer fitted with a Callender recording instrument. In the Brayshaw furnace the articles to be hardened were immersed in a large bath of molten lead, and, as the test pieces were treated singly, the temperature of the piece would be truly indicated by the pyrometer. The pyrometer was contained on a revolving drum at some distance

FIG. 1. TEST PIECE

from the furnace and differences of half a degree in the temperature could be seen at a glance.

The test pieces were heated for 15 minutes and then quenched vertically in a solution of 5 per cent. sulphuric acid. Tables 1 and 2 show the results of the preliminary experiments. Referring to Table 1, which deals with the alterations in dimensions introduced by the hardening of the test pieces, Fig. 1: Nine test pieces were dealt with, and these were hardened at temperatures varying from 730 up to 890 degrees Centigrade. The first column gives the alteration in the length, while the next four columns deal in the same way with the diameters at the points indicated. The remaining columns deal with the mean diameters. In all cases the unit equals 0.001 inch, that is to say, + 1.08 inches should read + 0.00108 inch.

The figures in columns *B*, *C*, *D* and *E* are the means of two measurements taken at right angles on the diameter. The figures show that in the case of these test pieces, increase in the temperature produced an increase of dimension. The increment of increase is as regular as might be expected. It is obvious that an increase in the bulk took place as the result of hardening, as practically the whole of the figures in Table 1 are prefaced by a plus sign.

### Review of Tables

Table 2 deals with the tempering of the same test pieces and shows the ultimate alterations in dimensions; the figures in this table are not additional to those in Table 1, as each table shows the relation of the test pieces to their original sizes. It will be seen that considerable alteration had occurred, particularly with regard to the length. Column *A* shows

*General manager, Newall Engineering Company, Warrington, England.

that alterations up to as much as 0.011 inch in 4 inches had taken place, while in the diameters *B*, *C*, *D*, and *E*, a reduction had also occurred.

A casual glance at the two tables is sufficient to show that the immediate effect of hardening was to produce expansion at all points, which, of course, means increase in bulk, and also that the immediate effect of tempering was to produce contraction. Another point that may be noticed is the tendency of the test pieces to go "barrel shape," that is, swell more in the center than at the ends.

The figures in Tables 1 and 2 have been plotted out in Fig. 2, in which the comparative effects of hardening and tempering can be seen at a glance. In this diagram the size before hardening is indicated by the horizontal lines, and the size after tempering by the fine lines. The hardening temperatures in degrees Centigrade appear horizontally, while the alteration in size can be found on the vertical line, which is magnified 1000 times, 1 inch representing 0.001 inch.

The topmost pair of curves in the diagram deal with the alteration in length, and show the comparatively great reduction that results by tempering as compared with hardening. The second and third pairs of curves deal in the same way with diameters, the end diameters *B* and *E* and the middle diameters *C* and *D*, respectively. The mean sizes are taken in these cases. The "barreling" effect is quite apparent after comparison of the two pairs of curves. The movement in the middle diameters is greater throughout than in the end diameters.

AFTER HARDENING.

| Test Piece No. | Temp. Deg. Cent. | Quenching Bath. | Length *A* | Diameters. | | | | Mean Diameters. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *B* | *C* | *D* | *E* | *B* and *E*. | *C* and *D*. | *B*, *C*, *D*, *E*. |
| 19 | 740 | Oil. | −0.78 | −0.21 | −0.01 | +0.02 | −0.39 | −0.30 | +0.05 | −0.14 |
| 20 | 740 | Water. | −1.07 | +0.93 | +1.18 | +0.75 | +0.81 | +0.87 | +0.96 | +0.92 |
| 21 | 740 | Caustic | −3.15 | +1.10 | +1.66 | +1.72 | +1.18 | +1.14 | +1.69 | +1.41 |

AFTER TEMPERING.

| Test Piece No. | Temp. Deg. Cent. | Quenching Bath. | Length *A* | Diameters. | | | | Mean Diameters. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *B* | *C* | *D* | *E* | *B* and *E*. | *C* and *D*. | *B*, *C*, *D*, *E*. |
| 19 | 740 | Oil. | −0.80 | −0.30 | +0.03 | −0.01 | −0.48 | −0.39 | −0.01 | −0.19 |
| 20 | 740 | Water. | −2.65 | +0.56 | +0.62 | +0.10 | +0.46 | +0.51 | +0.36 | +0.43 |
| 21 | 740 | Caustic | −6.07 | +0.61 | +1.43 | +1.42 | +0.85 | +0.73 | +1.42 | +1.07 |

TABLE 3. EFFECT OF QUENCHING BATH. FIG. 1. UNIT = 0.001 INCH.

This effect would have been more decided had the test pieces been left plain cylindrical, instead of screwed, on the ends.

### The Effect of Different Quenching Baths

The next step in the experiment was to determine the effect of different quenching baths on the movement caused by hardening and tempering. For this purpose three of the test pieces, Nos. 19, 20 and 21, Fig. 1, were heated at the same time to 740 degrees Centigrade and quenched in different baths. Test piece No. 19 was quenched in oil, No. 20 in water and No. 21 in a strong solution of caustic soda. The different effects produced are shown in Table 3. Very little movement took place in the piece quenched in oil, more occurred in the one quenched in water, while No. 21, which was quenched in the caustic bath, showed considerable movement. It will be observed also that the less the alteration in hardening the less the movement in tempering. The figures in this table are plotted out in Figs. 3 and 4. Two sets of curves are given showing, respectively, the alteration after hardening and after tempering. The horizontal line represents the size before hardening, the small circle at *A* the alteration in length, and the circles *B*, *C*, *D* and *E* the alteration in diameter. Test piece No. 19, which was quenched in oil, was not sufficiently hard at this temperature; therefore the experiment was repeated at a much higher temperature, but the results were proportionately the same.

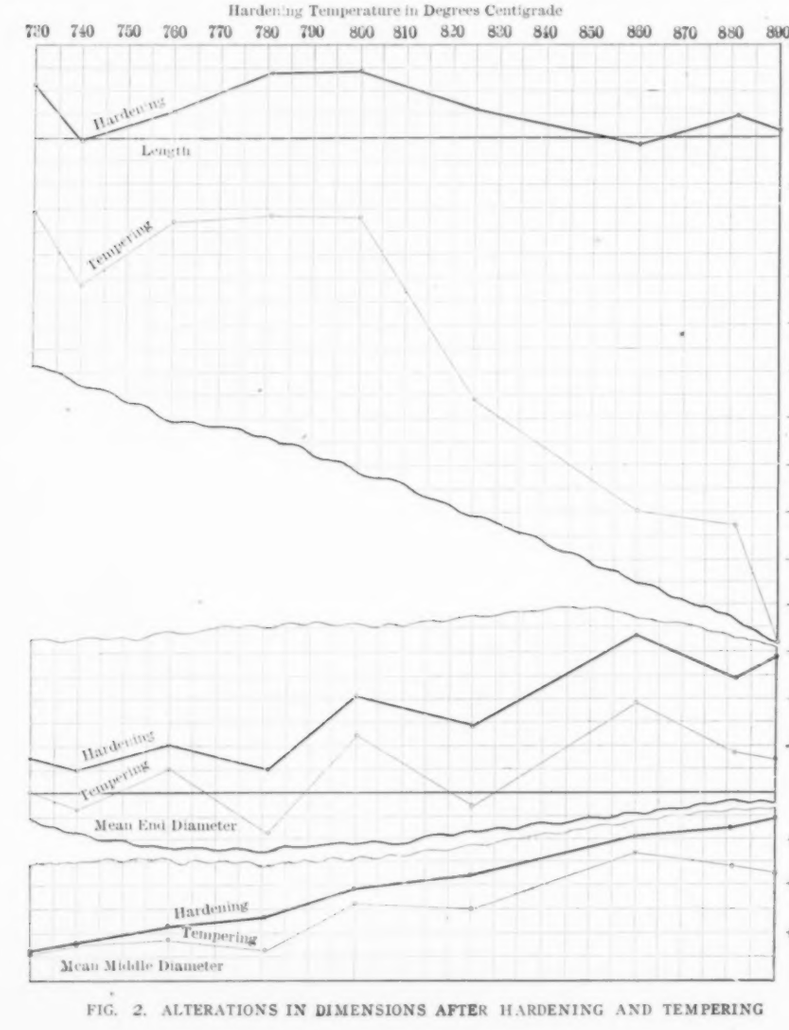



FIG. 2. ALTERATIONS IN DIMENSIONS AFTER HARDENING AND TEMPERING

### Expansion or Contraction

Previous observations of a more or less casual nature conveyed the opinion that, in the majority of cases at least, the effect of hardening was to produce contraction. The figures in Table 1 point conclusively to the contrary, but Table No. 2 leaves this in doubt.

The volumes of three of the test pieces, Nos. 6, 8 and 11, after hardening and tempering have been worked out, are compared in Table 4 with the volume of the pieces before treatment. This shows that an increase in the bulk took place even after the reduction caused by tempering. In order to determine whether the shape of the piece was responsible for this, a piece similar to that shown in Fig. 7 has been treated and the results tabulated in Tables 5 and 6.

Before hardening this piece was measured at three points on the diameter and at three points in the hole. The length was measured at four different points on

the outer edge and four on the inner edge, that is, immediately round the hole. The sizes at all these points are given in Table 5 before and after hardening and tempering, as also is the amount of alteration in each dimension after hardening and tempering.

An examination of the figures shows that considerable contraction took place on the diameter, and, considering the weight of the piece, very little movement took place in the length on the outer edge. The great increase in the length at the inner edge and the great reduction on the hole show where the metal went to. This peculiar movement is due to the method of quenching, as will be explained later.

Notwithstanding the great amount of movement that took place in this piece, Table 6 shows that an increase in bulk resulted, basing the calculations on the mean outside diameter, length and diameter of hole before and after hardening

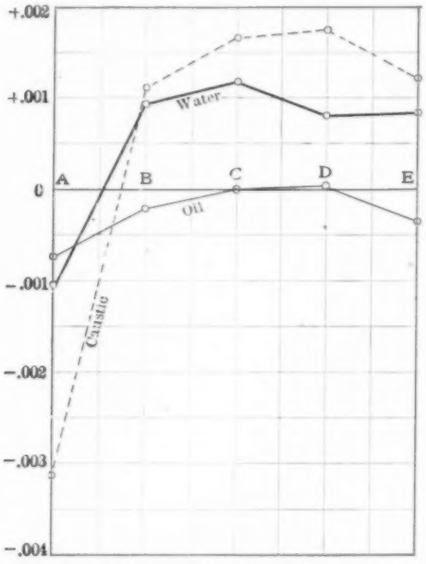



FIG. 3. ALTERATIONS AFTER HARDENING AT 740 DEGREES

and tempering. It can therefore be taken as an established fact that expansion, not contraction, takes place, although it is quite conceivable that, under some circumstances, contraction might appear to have occurred.

### The Effect of Size, Shape and Method of Quenching

A great deal depends, not only upon the steel but also upon the shape and size of the piece, the method of quenching and the quenching bath. Figs. 5 and 6 show the effect of size and shape upon the movement; the hard line represents the shape before hardening, while the dotted line represents the shape after hardening. In both cases the articles are hardened flat face downward.

If a piece of exactly the same proportions as Fig. 6 is quenched in a different manner, an entirely different movement takes place. This can be seen in Fig 7, which is a piece of the same proportions as Fig. 6. The dotted line, representing the shape after hardening, takes an altogether different form in this case, which is the result of rolling it down an incline into the quenching bath instead of dipping it vertically, flat edge downward, as in the case of Fig. 6. The dotted lines in these three cases are, of course, exaggerated.

The difference in the movement is, no doubt, due to the peculiar action produced by molecular expansion. Although it has been shown that the ultimate result of hardening and tempering is an increase in the bulk of the piece, an examination of the figures and diagrams will show that where the articles meet the water and consequently where the hardening effect is at its greatest, the result is in the direction of contraction and not expansion. This is a point that merits a thorough scientific investigation.

It is difficult to understand why the expansion does not follow the line of least resistance. If the expansion is due to the change of carbon from hardening carbon to pearlite, the solution of the problem may be found in the theory that where the piece being hardened comes first in contact with the cooling medium, a skin hardness is instantly obtained at that particular point, while other parts of the outside are still hot, as well as the core of the metal. This being so, it would seem that the effort exerted by the core of the metal during the conversion of the carbon would be, to a certain extent, resisted by the hard skin and cause the article to bulge, as it were, where the metal retains its heat longest.

| | Test Piece Number. | Length, Inches. | Mean Diameter, B,C,D,E Inches. | Volume Cu.In. |
|---|---|---|---|---|
| Soft | Original Size | 4 | 0.850 | 2.26980 |
| After hardening | 8 | 3.99994 | 0.85009 | 2.27346 |
| | 11 | 4.00138 | 0.85199 | 2.28123 |
| | 6 | 4.00012 | 0.85315 | 2.28673 |
| After tempering | 8 | 3.99841 | 0.85029 | 2.27045 |
| | 11 | 3.99830 | 0.85143 | 2.27648 |
| | 6 | 3.99920 | 0.85151 | 2.27172 |

TABLE 4. ALTERATION IN BULK. FIG. 1.

DIAMETER (OUTSIDE).

| | Front. | Center. | Back. | Mean. |
|---|---|---|---|---|
| Soft | 5.9671 | 5.9672 | 5.9673 | 5.9672 |
| Hard | 5.9588 | 5.9574 | 5.9569 | 5.9577 |
| | —0.0083 | —0.0098 | —0.0104 | —0.0095 |
| Tempered | 5.9586 | 5.9571 | 5.9566 | 5.9574 |
| | —0.0085 | —0.0102 | —0.0107 | —0.0098 |

DIAMETER OF HOLE.

| | Front. | Center. | Back. | Mean. |
|---|---|---|---|---|
| Soft | 0.9810 | 0.9900 | 1.0000 | 0.9903 |
| Hard | 0.9796 | 0.9740 | 0.9984 | 0.9840 |
| | —0.0014 | —0.0160 | —0.0016 | —0.0063 |
| Tempered | 0.9785 | 0.9750 | 0.9980 | 0.9838 |
| | —0.0025 | —0.0150 | —0.0020 | —0.0065 |

LENGTH (INNER EDGE).

| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | Mean. |
|---|---|---|---|---|---|
| Soft | 2.5030 | 2.5030 | 2.5028 | 2.5025 | 2.5028 |
| Hard | 2.5217 | 2.5220 | 2.5210 | 2.5214 | 2.5215 |
| | +0.0187 | +0.0190 | +0.0182 | +0.0189 | +0.0187 |
| Tempered | 2.5215 | 2.5218 | 2.5208 | 2.5211 | 2.5213 |
| | +0.0185 | +0.0188 | +0.0180 | +0.0186 | +0.0185 |

LENGTH (OUTER EDGE).

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | Mean. |
|---|---|---|---|---|---|
| Soft | 2.5032 | 2.5020 | 2.5000 | 2.5008 | 2.5015 |
| Hard | 2.4995 | 2.5000 | 2.4999 | 2.5014 | 2.5002 |
| | —0.0037 | —0.0020 | —0.0001 | +0.0006 | —0.0013 |
| Tempered | 2.5005 | 2.5005 | 2.5000 | 2.5020 | 2.5007 |
| | —0.0027 | —0.0015 | +0.0000 | +0.0010 | —0.0008 |

TABLE 5. ALTERATION BY HARDENING AND TEMPERING. FIG. 7.

| | Diameter, Inches. | Length, Inches. | Hole, Inches. | Volume, Cubic Inches. |
|---|---|---|---|---|
| Mean size, soft | 5.9672 | 2.5021 | 0.9903 | 68.04680 |
| Mean size, hard | 5.9577 | 2.5108 | 0.9840 | 68.08453 |
| Mean size, tempered | 5.9574 | 2.5110 | 0.9838 | 68.08368 |
| Alteration by hardening | —0.0095 | +0.0087 | —0.0063 | |
| Alteration by tempering | —0.0098 | +0.0089 | —0.0065 | |

TABLE 6. MEAN ALTERATION IN DIMENSION AND BULK. FIG. 7.

### Method of Immersion Effects Distortion

A little consideration of the way in which the flow of water meets the article during immersion in the quenching bath will readily explain this action. Figs. 6 and 7 show this effect very well. Fig. 6 was immersed, flat face downward, and moved up and down, the flow of water

being greatest on the flat faces and corners. On the other hand, Fig. 7 was rolled up and down an incline in the quenching bath, and met the flow of water on the periphery.

It seems clear that expansion takes place as the result of hardening, but the percentage of increase in the volume of the piece hardened is so small that the greatest trouble is undoubtedly due to the distortion in shape produced by the peculiar effect described above. The percentage increase in bulk amounts only to about 0.085 per cent. in the case of Fig. 1 and 0.055 per cent. in the case of Fig. 7, as is shown by Tables 4 and 6.

### Expansion the Cause of Flaws and Cracks

Although flaws and cracks are usually attributed to uneven heating, I am strongly inclined to the opinion that the root of the evil is to be found in this peculiar action; that is, the change in bulk due to the action of quenching and the method of handling the pieces in the bath.

The experiments, as far as they go, indicate that the effect of hardening is expansion. Tempering reduces the amount of this expansion. The percentage increase in the volume is extremely small, therefore the distortion is more important than the increase in bulk. Where cooling occurs first, the increase in dimension is least and sometimes negative, depending upon the size, shape of the piece and the method of quenching. The higher the temperature the greater the distortion.

Although the foregoing represents only a portion of the series of experiments that have been carried out along this line, the samples quoted are perhaps sufficient to base those conclusions upon.

## Training Married Men to be Machinists

By R. E. Marks

The experience of Mr. Alvord in training apprentices has not been altogether pleasant and yet I do not believe that all of the boys of today are no good in the shop, or that they are any worse than they were when we older ones learned our trades. As a matter of fact I think they are better. If all employers followed the practice of teaching only married men there would be nothing for a boy to do but knock around at odd jobs, go behind the ribbon counter or jerk soda water until he saved up cash enough to get married, or had a leap-year game sprung on him when he couldn't get away. And then he is only a candidate for learning the trade.

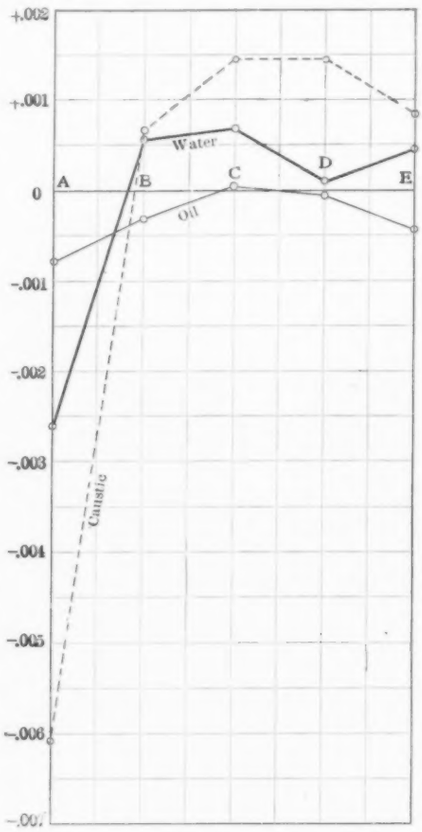



FIG. 4. ALTERATIONS AFTER TEMPERING AT 200 DEGREES CENTIGRADE

I can imagine the fervid tones in which Alphonso pleads with Gwendolynne to share his lot while he is learning to be a machinist at about one fifty per and holding out the prospect that at some dim and distant future he may be able to double this princely stipend. And unless Gwendolynne approacheth the sear and yellow and sees her marriageable future behind her, I can hear her say No! with two capitals.

It's a pretty safe test for any plan of this kind to just imagine what would happen if all shops should adopt it. And taken by this test I don't see any dazzling future for the scheme of making a man marry so he doesn't dare throw up his job anyhow, before you give him a chance to learn a trade. The gap between the school age and the time when family cares begin to furrow a man's brow, is too long and too fraught with danger to let boys drift before teaching them a trade or part of it.

Mr. Bullard's plan of training both regular and special apprentices appeals to me as the safest that has been proposed.

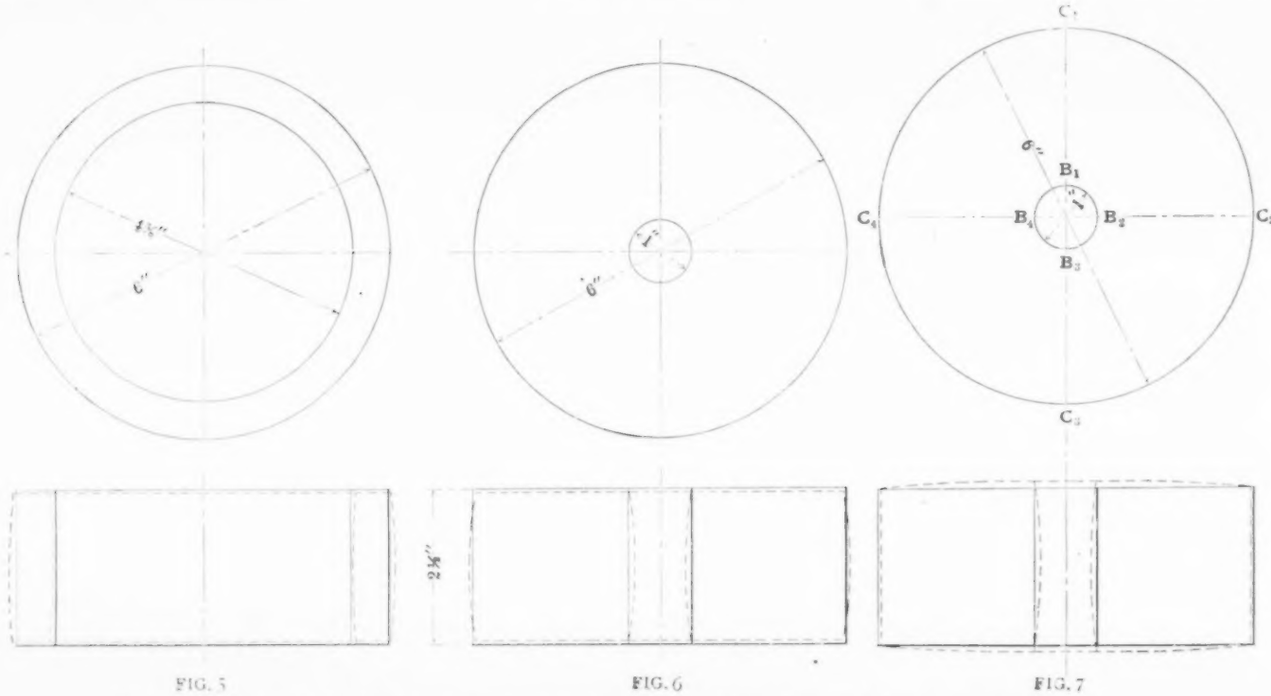



FIG. 5 FIG. 6 FIG. 7

ALTERATIONS IN SHAPE BY HARDENING AND TEMPERING WITH CERTAIN METHODS OF QUENCHING

# Auger Making in an Old American Shop

## Methods of the Oldest Auger Maker in America Who Is Still Making Them in the Good, Old-fashioned Way

## EDITORIAL CORRESPONDENCE

Way back in the days when the spirit of revolution was brewing among our forefathers, just after the Boston Tea Party set all the Colonies to wondering what was coming next, there was started in Philadelphia the first American shop for the making of augers or bits for boring holes in wood and which are used so universally that every boy is familiar with them. So in 1774 the name of Job T. Pugh began to be known as a maker of hand forged augers for carpenters and millwrights, has continued to the present, through five generations and is now in the hands of the third descendant bearing the same name as the founder.

Stranger than this is the fact that through all these years, in which the country had its infancy and its present development, the Pugh auger has continued true to its original reputation and is probably the best known hand-made tool in the trade. True the helve hammer has succeeded the blacksmith's helper for the forging of the augers, but they are still worked out of the solid and handled in very much the same way, except for such improvements as tend to increase uniformity of product, as they were in 1774—one hundred and thirty-four years ago.

A shear at the right of the blacksmith shown in Fig. 1 cuts the square stock to length and this is drawn out into the shapes shown by the upper views in Fig. 9. Of course he has dies to help shape these, but if anyone thinks it can be done without any skill he has another guess; the smith in this case is an expert and turns them out with great uniformity and in quick time.

### Twisting and Crimping

From here they go to the man shown in Fig. 3; although this is not the only one of the kind, and this is one of the most interesting departments in the shop. After being heated in the hard-coal fire shown in the center, the straight blank is put into the "wringer" or twisting machine shown with the handle raised just this side of the furnace. One has just been twisted as can be seen in the machine.

The steel does not twist with absolute uniformity as any mechanic knows who has tried to make a scriber by twisting a square bar of steel and this variation in the twist is taken out by the "crimping machine" shown in the foreground. This carries two dies, one in the ram at the right which is moved back and forth by the crank shaft with the fly-wheel, while the other is controlled by the hand lever at the left. After being twisted they are "crimped" between the dies until the twist is uniform to whole length, so that the chips may flow easily out of the spiral groove. Some of these machines for smaller sizes are entirely hand operated and some of the dies may be seen on the planer table in Fig. 5.

### Shaping the Cutting Edges

Now the fine hand work commences. The bit maker puts the hot point between the jaws of the vise behind him, gives it a deft twist to shape and draw out the point, shapes the cutting lips on the anvil and on the various small anvils at the extreme left; uses a long narrow cross pene hammer to shape the throat and draw these cutting lips to shape and in fact put on the artistic touches which go to make up the difference between a well made, hand-forged bit and one that most of us, not knowing the requirements, would probably produce. Then, too, he must be sure they are not forged too small on the points and so he measures each one with calipers to be sure it is large enough to finish to size.

The twisted bits then go to the press shown in Fig. 2, which carries a hollow punch having lips which look something like a shearing boiler punch, but which

FIG. 1. FORGING THE BIT FROM THE ROUGH

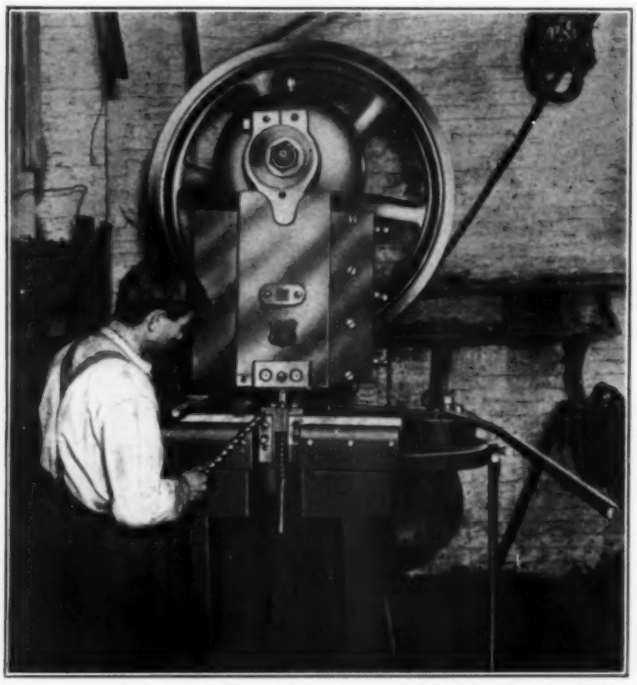


FIG. 2. FORMING THE CUTTING LIPS

help to shape the point and give a uniform lead to the cutting edges between the lip and the point.

From here they are taken in charge by the men who gouge out the throat with slow-running milling cutters of the right shape. The point of the bit rests in a wooden block in the lever to hold it steady. Then the lever is pressed down to bring the bit against the top of the cutter and the bit wabbled by hand to bring every point in contact with the mill, so as to make the outlet for chips smooth and easy. The other operator is backing off the cutting edges with a similar milling cutter. These are shown in Fig. 4.

### Threading the Leader

On my first visit to the shop I looked all over to find the machine which threaded the leader or point, but without success. But closer observation revealed the fact that most of these were not threaded in any machine, but by hand. A special file is used, with the section like a warding file, having V, instead of round-edged, and cut only on the V's. These files are usually made by the men themselves. Then the shank of the bit is laid in a rest made of an iron rod, to support the outer end, the point (which has previously been trued up by a hollow mill in a speed lathe) is laid on a hardwood block which is clamped in the vise and the thread is filed in by hand. Starting at the large end and coming out from the groove on one side, the bit is revolved as the file cuts its way into the leader and works the thread out toward the point. On some bits a double thread is used, one starting from each groove; on others only a single thread, but in each case they are filed more uniformly and more quickly than one would suppose possible. Great care is taken to have everything smooth and easy so that neither the thread of the leader nor the throat of the bit will clog up with chips, this being one of the essential points in a good working bit, and the fact that Pugh has withstood the competition of machine methods and has a steady demand for the hand-made article shows that there is something beside the quantity of output behind any business. More than this, he is now occupying a much larger building than when I first knew the plant, more years ago than I like to think about.

### A Threading Machine

There is a machine for threading the leaders, however, which he uses on some of the larger bits and this is shown in Fig. 7. It consists of a steel disk or head mounted on the spindle of the machine, this disk having a series of grooves or rings to form the threads. There are also a few radial notches which allow the point to get a grip on the disk, as they cannot be called cutting edges. The shank of the drill is held in a tailstock that is threaded to the pitch of the lead screw and the operation is to force the point against the revolving disk, run the bit back with the tailstock and in this way gradually force the metal in the leader into the grooves of the disk.

FIG. 3. HAND TWISTING, CRIMPING AND FORGING

### Veteran "Bill" Johnson

Fig. 5 shows a man who is familiar to the whole auger-making trade, as he has made dies and tools for them all. Ask any of them about Bill Johnson and they'll know who you mean, but I was warned not to call him William by everyone from Mr. Pugh down. Several sets of dies for the crimpers are shown on the planer table and a pair for single bits are seen at the extreme right with only a single bar across the opening. He is planing up some hammer dies to flatten the blanks shown on the planer vise. Bill is a veteran of the Civil war, was in Andersonville, etc., but the empty sleeve is due to an accident afterward. He came through the war without a scratch, to be done up by a lamp explosion.

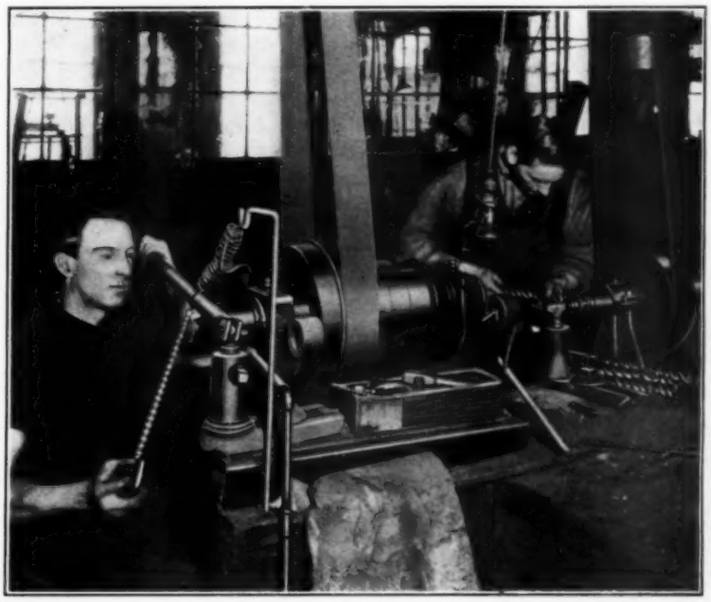


FIG. 4. GOUGING OUT THE ENDS

FIG. 5. MAKING THE FORGING DIES

It takes several passes to get a good thread and the heat generated often turns the points blue. This operation sometimes hardens the points so they have to be annealed before they can be dressed up and this probably results from the surface pressure rather than the heat. The time taken is not so much less than the hand-thread filing as you might imagine and this is only used on the larger sizes. Both the men in Figs. 6 and 7 have been with the house of Pugh over 40 years.

The final sizing is done by the same men who file the leader threads, caliper rules and gages being used, then they are tempered to a pigeon blue, ground and polished in the usual way. Fig. 8 shows the three operations of grinding the outside, the grooves and the shank on regular buffing wheels. The dust is taken away by exhaust fans.

### Testing for Straightness

Before packing the bits must all be tested for straightness, and it is to this careful inspection that Mr. Pugh attributes much of the success of the business. The Pugh eye has been noted during all the five generations for its ability to detect "spring" in the bits when spun with their points on a fixed spot and so it was entirely in keeping with their long years of precedent to find the present Mr. Pugh personally testing some double size bits, perhaps three-quarters in front and a counterboring part of two inches in diameter, which were going to the Panama canal job for work on lignumvitae timbers. These were particularly difficult to test for straightness, which accounts for his personal supervision.

Fig. 9 tells the story of the progress

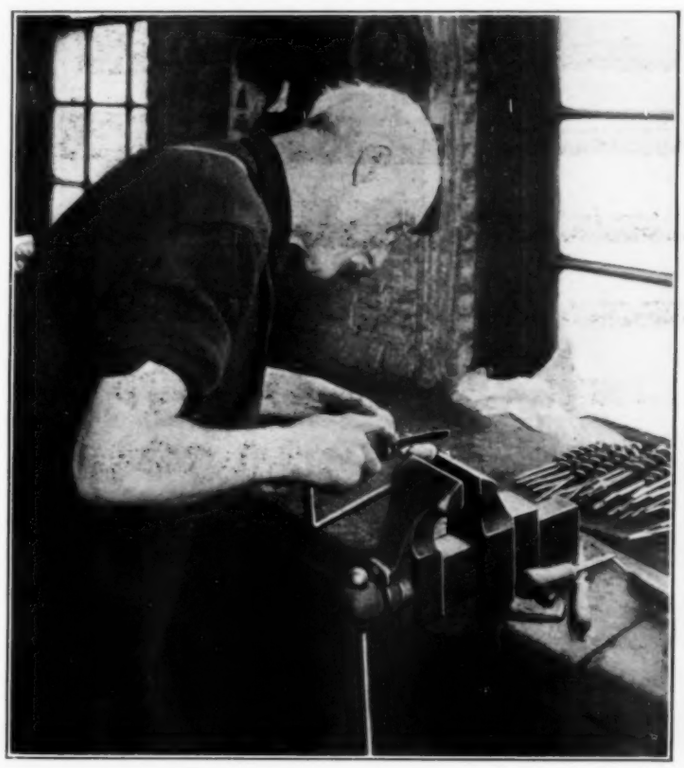


FIG. 6. FILING THE THREAD ON THE LEADER

FIG. 7. ROLLING THE LEADER ON LARGE BITS

from start to finish and shows how the cutting lips grow into shape from the twisted end of the flat stock.

Altogether it is an interesting and unique industry, where individual skill counts for much and where men grow old and die in the harness. And the fact that an establishment exists where hand work is profitable, shows that there is still a field for it in some lines.

F. H. C.

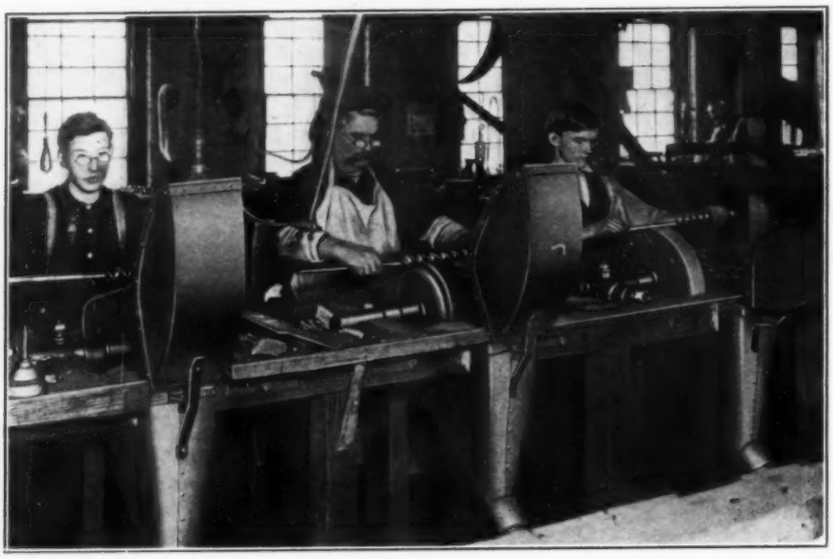


FIG. 8. GRINDING AND POLISHING

## Get What You Earn and Earn What You Get

By Con T. Wise

I have just come from an interview with a manufacturer for whom I have been doing some designing. On a card over his desk I saw this, "Folks who never do any more than they are paid for never get paid for any more than they do," or words to that effect. I pointed to the card and said: "I see you believe in doing just what I want you to do. You know that I have done a considerable amount of work on this last machine that neither you nor I contemplated when we made our trade. I agreed to do a reasonable amount of work in looking after the job; through the incompetence of your foreman I have had to do an unreasonable amount. That is, I have done more work than you have paid for. Now by your card here I understand that you believe that I should therefore be paid for more than I have done."

He wheeled around, looked me over and said, "Young man, you have got that all wrong; and beside you ought to look at the other side." I turned the card over and there it said, "The more you do for a man the less he will do for you." Then he went on:

"You see, if I should do everything for you that you wish, I know human nature well enough to know that you would soon come to think that you owned me and my shop, and could do as you pleased. On the other side of the card there is nothing that says that a man shall receive any more than he earns, no matter what he does. The inference is easily made, but the statement is not there and any man who receives something that he does not earn is injured by it. The more he gets that he does not earn the more he will demand.

"Every man ought to be paid for what he does and no more. If he has a business head on him he will see to it that before he begins work he contracts to be paid for all he does; if he does not make a good bargain, that is his own fault. Unfortunately, in the past, men who have had the ability to earn money seldom have had business sense to go with it, so the employer has been looked upon as a sort of philanthropist who could be expected to look out that his men were paid justly whether they asked it or not. This has all changed now and every man has only himself to blame if he sells his services for less than they are worth. No man ought to want to be paid more than he is worth. If he does get more, he despises the one who gives it as a poor business man, and he does not hesitate to try to get all he can. If a man wishes more pay, he must first earn it; if he gets more than he earns, he should despise the man who gives it; if less, he should despise himself."

Oh! by the way, I got mine after all.

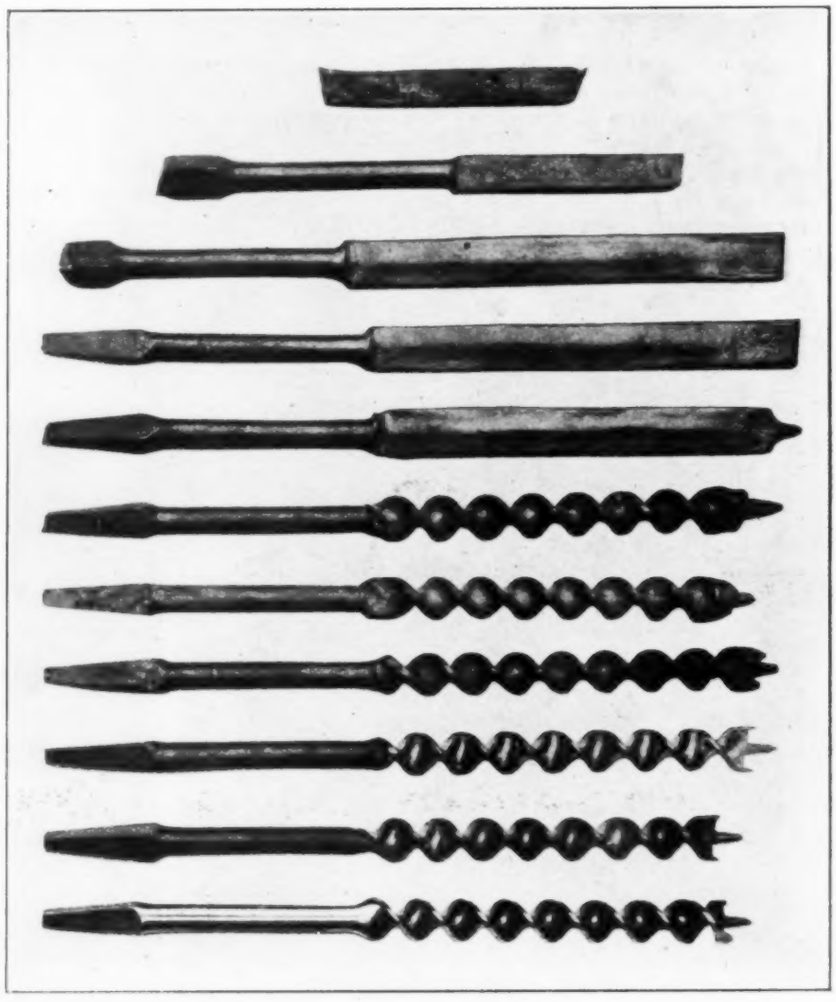


FIG. 9. THE EVOLUTION OF THE AUGER

# Practical Letters From Our Readers

## A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

## WE PAY FOR USEFUL IDEAS

### Crank-pin Turning Device

Some time ago we had occasion to true up the crank-pins of a double 34x60-inch simple Corliss engine that had been worn so out of round that the engine pounded like a steam hammer. As there was no crank-pin turning device available and as all machinists know it is a heart-breaking job to attempt to file a crank-pin 7¾ inches diameter and 7½ inches long, round and square with the face of the crank, I proceeded to design the device illustrated. It is a cheap and simple rig and did what it was intended to do satisfactorily and in a very short time. It can be made in any one-horse shop and will answer the purpose as well as a $400 crank-pin turner. It consists of two rings *R* and *R'* fastened together with three faced spacers *S S' S"* set at 120 degrees to each other. Cap-screwed to the inner finished faces of the spacers are three bearing blocks *B B' B"* which fit the diameter of the outer and enlarged end of the pin *A*. The inner ring *R'* is bored to fit the enlarged spacer end *L* of the pin, which shoulders against the crank.

Between two of the spacers a piece of finished square key steel *B* is fitted and fastened with set-screws to the rings *R R'*; it acts as a guide or way for the tool carriage *C*. The tool carriage, or the movable block to which the turning tool is fastened or clamped, has a squared hole through it to fit the way or guide bar *B* and is free to move along it without wabbling.

A hole is bored and tapped through the end of the carriage for the feed screw *S*. Attached to the end of the feed screw is a small rope sheave, which is belted to the sheave part of the handle *H* with a ½-inch rope, giving an automatic feed when the machine is in operation.

In making a device of this kind, the hole in the ring *R'*, preliminary to the final finishing, should be left small, and the three bearing blocks should be cap-screwed to the spacers, the backs of the bearing blocks only being finished. When the spacers have been cap-screwed securely to the rings *R R'* the partly assembled machine should be chucked in a lathe and the bearing blocks *B B' B"* bored and faced to fit the end *A* of the crank-pin. The hole in the ring *R'* should then be bored to fit that part of the enlarged pin nearest the crank. This being done, the square way *B*, tool carriage and feed screw can be put in place.

On attaching the machine to the crank-pin, the three bearing blocks are removed, the machine slid over the crank-pin until the ring *R'* fits over and against the enlarged end of the pin *L*, and against the face of the crank. The bearing blocks *B B' B"* are then fastened in place, the tool adjusted, and the machine is ready to do business.

THOMAS EVANS.

Great Falls, Mont.

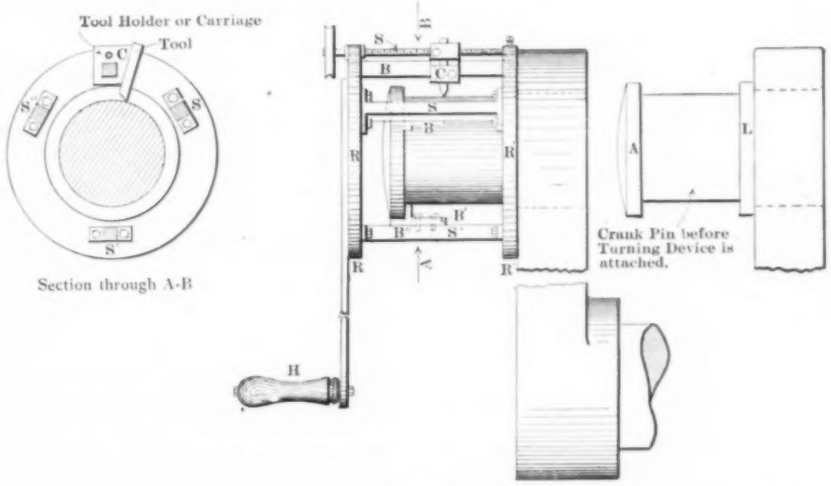



FIG. 2. THE WORK AND THE DEVICE

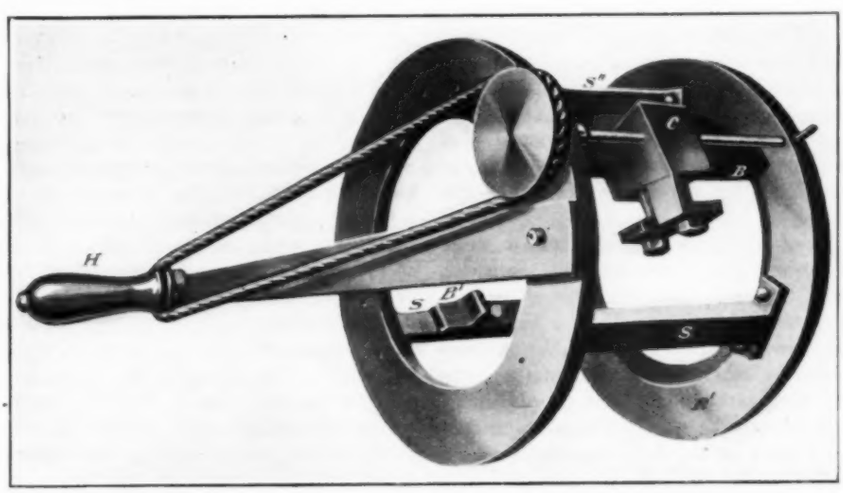


FIG. 1. A CRANK PIN TURNING DEVICE

### The Status of the Draftsman

Something of the same feeling which J. F. Winchester expresses in his article occurred to me when reading the previous Troubles of a Tool Designer, page 983, Vol. 30, Part 2. I have frequently found that when young engineers desire to become draftsmen without the necessary years of training, they attempt to attain proficiency by graduating as tool and jig designers, and the inevitable troubles that result are not occasioned by unfair treatment, but through lack of experience to carry out the work they engage upon. While I do not consider that this branch of engineering requires a great amount of theoretical knowledge, I do think it calls for a thorough shop training. Far more reason has the machine designer or thoroughly experienced draftsman in any branch to complain of the status allotted to him, not only by the shop hands but by the average employer.

In the case of the former, even in these advanced days, it is only too common to find that the draftsman is rarely supposed to know the difference between a spanner and a file, when (putting aside the fact

that if he doffed his coat, he might in many instances give points to his judge at the bench or machine), by the exercise of even a little common sense it would occur to the shop man that the majority of our modern machine wonders emanate from the brain of the despised draftsman.

I would suggest to the average fitter or erecter who holds adverse views of the drawing office in general to remember that the finished machine which he frequently takes pride in after passing through his hands, was evolved in the first instance from the designer's brain, and that it was weaved with all its maze of parts and fine clearances *on paper*.

Apart from any consideration of the years of study necessary to become a successful designer, if this attitude were more general I think we should hear fewer remarks about "that fool of a draftsman" when a foul does happen to occur.

This last question of errors calls to mind the matter of checking, and although I am completely in favor of this being done by a second or even third party, believing that few draftsmen after a week or more on a drawing retain sufficient interest to give careful attention to their own work, at the same time it is only right, if they are to retain their self respect, that the checking should be done by competent trained draftsmen and not by semi-clerks as is frequently the case.

Glasgow, Scotland W. C. HARTLY.

## Getting Out Broken Taps

Getting broken taps out is, in one shop at least, made easier by pouring muriatic acid into the hole. Leave it there for about four minutes and enough of the tap and the hole is eaten away to loosen the tap.

Bangor, Pa. J. SCHURING.

## Notes on Beam Design

The resistance moment of an open beam is equal to the depth of the beam, measured from the centers of gravity of the flanges, multiplied by the area of one flange, always the weaker one in case there is any difference. The compression flange must, of course, be proportioned to resist thrust, but that is another matter. A girder should not be considered as an open beam, or truss, except when it is so constructed that only direct tension or compression can come upon the flange members. If it is built so that the flanges will become curved under a load, the same as a beam with a solid web, the above rule for resistance moment does not apply.

Many draftsmen figure all beams with light webs as open beams, introducing an error which is usually on the side of safety, but this may not always prove to be the case.

Let $R$ = *resistance moment of an open beam calculated as above noted.*

$S$ = *section modulus of any beam,* that is, its moment of inertia divided by the distance from the neutral axis to the extreme fibers.

Then for Fig. 1 $S = 96$ while $R = 100$; an error of 4 per cent. on the danger side.

In this case the stress set up in the extreme fibers by the curving of the flanges, which is not taken into account in figuring by the open-beam method, is too great to be offset by the strength of the web member, which is also neglected. The proportions shown in this section are so extreme that they are not likely to occur in practice, but they serve to illustrate the principle.

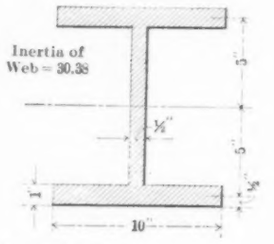



FIG. 1

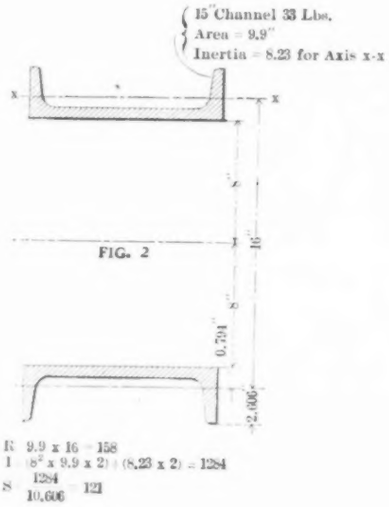



FIG. 2

EXAMPLES OF BEAM DESIGN

A more noticeable case which came under my observation was one in which a draftsman designed a girder of the section shown in Fig. 2. This he figured as an open beam, the channels being connected by lattice bars, but the latter were so strong and rigid that the chords would deflect much the same as though connected by a solid web. The modulus for this section is only 76 per cent. of the resistance moment figured as an open beam. I suggested turning the channels as shown in Fig. 3, but the draftsman objected as this would be more difficult to construct and, he claimed, would be no stronger, as the moment of inertia would be the same if the distance from the center of gravity of one channel to that of the other was unchanged. This is another mistake sometimes made. The strength of beams varies as the section modulus, not as the moment of inertia. The section modulus for Fig. 2 is 121, that of Fig. 3 is 146, showing a great increase in strength by turning the channels with their backs outward and getting the metal in the web as far as possible from the neutral axis. Of course, in a truss, with the web members so connected that only direct tension or compression can come upon the channels, it would matter little which way they were placed.

The member shown in Fig. 4, consisting of a rolled-steel bar with holes drilled along the center line to admit of rods being passed through, was loaded as a beam; the designer in this case also figured it as an open beam, getting a resistance moment of 48. The section modulus is really 33, while that for the solid section is only 33.34, an exceedingly small increase and very much less than that figured as an open beam. In other words, if the draftsman's view was correct, the beam would actually be made stronger by drilling the holes in it. There are many cases occurring in construction in which the strength of a member may be increased by the removal of superfluous metal, but this is not one of them.

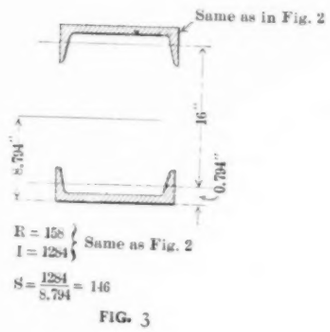



FIG. 3

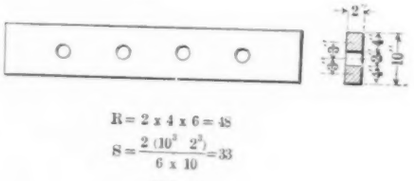



FIG. 4

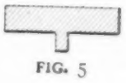


FIG. 5

EXAMPLES OF BEAM DESIGN

To put a small, thin rib on the ten-

sion side of a gray-iron slab, as in Fig. 5, would only be to introduce an element of weakness.

GERALD E. FLANAGAN.

Pittsburg, Pa.

## Is the Inverted-V Type of Lathe Bed All Wrong?

I was very interested in F. J. B.'s article on page 105, comparing British and American lathes. Like him, I learned my trade in England and have had a large and varied experience on both English and American lathes, from Whitworth's and Pratt & Whitney's down to unnameable monstrosities only fit for the scrap heap, I have always found, on the average, that the American lathe is easier to operate, but it is not so rigid as its British cousin. I am of the opinion, however, that F. J. B. is in error when he attributes this stiffness to the coned bearings common in English practice. I think the difference is due to the solid bearings. A capped bearing can never hope to be as rigid as a solid one; be it parallel or taper. I have always found that taper bearings wear fast on the large end and the fit is soon lost, but even when there is a shake the lathe will have less tendency to chatter than a well-set up lathe with capped bearings.

The most rigid lathe I ever worked on was an old English 20-inch swing lathe that had been refitted several years previously. The worn taper bushings were forced out, the parallel holes in the head were carefully lapped and a new spindle fitted direct to these holes. Though of course of large diameter it ran very freely, with no appreciable shake even after several years of service. It was really quite a difficult thing to make that old lathe chatter, even on heavy chucking work.

Another point I would like to insist on is the great difficulty on the English type of lathe of keeping chips from getting between the saddle and the bed, especially when oil or suds are used on the work. Needless to say this causes rapid scoring of the ways. I have run English lathes where a cut 1/16-inch deep could be caused by just leaning on the tool post, although the saddle went very hard. In spite of this, however, the boss would not hear of time being "wasted" on refitting the ways.

JOHN P. WHEELER.

New York City.

## Jig Bushings

Recently there have appeared in your columns descriptions of two jigs in which screw-threaded bushings are employed for purposes of adjustment. Doubtless they served their designed function admirably, but as a matter of principle they represent poor practice. A jig bushing should be accurate itself and in the mode in which it is located and held in place. Neither can be satisfactorily attained where a screw thread is used. A cylindrical bushing can be ground both externally and internally and thus made true within close limits of accuracy. An externally threaded bushing can be ground internally only and thus falls short of the accuracy of the cylindrical bushing.

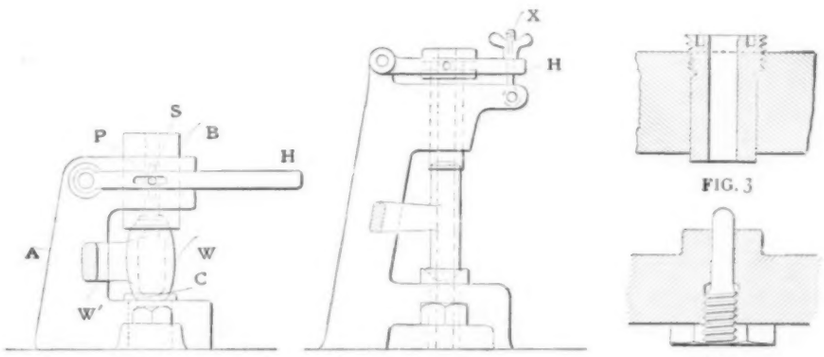



FIG. 1 FIG. 2



FIG. 3 FIG. 4

SLIDING JIG BUSHINGS

Where the bushing performs the dual function of securing the piece to be drilled and directing the drill as well, it is best made cylindrical, slidable in its seat and controlled by some means outside of itself.

The form of jig illustrated at Fig. 1 was used for enlarging some cored holes to 5/8 or 3/4 inch. The bushing was cylindrical and slid in its bearing. To close it upon the work, a hand lever was employed which sufficed to hold the work. The cut was short and did not permit use of power feed.

The frame *A* was secured to the drill platen and the work was bored between the slidable bushing *B* and the seat *C*. Both the bottom of the bushing *B* and the seat *C* were cupped to center the work *W*, which was prevented from turning by the projection *w'* that encountered the frame of the fixture. A pin *P*, driven into the bushing and guided by the slot *S*, engaged the lever *H*, by which the bushing was raised to admit work to the fixture and depressed to hold the work in position.

Another form in which this device is used is with a screw or other means for locking the bushing where power feed is to be used. The adaptation is obvious without detailed description, the lever *H* in this case being secured by the latch screw *X*; see Fig. 2.

The same general form has been seen used on heavy work, with the sliding bushing actuated and locked by compressed air instead of by mechanism or manually.

A further reason for avoiding the use of screw threads is that fine chips work in between the threads and tend to clog them, more than they do with a sliding bushing.

If a screw-threaded bushing must be used, it should be long with a straight cylindrical bearing most of its length, and just sufficient thread to secure it or secure the desired degree of adjustment. The cylindrical seat for the bushing can be reamed and the body of the bushing can be ground externally and internally. The engagement of the threaded part should be free, as the bushing should be controlled by the cylindrical portion only. Of course the precise form of the bushing may be varied: It may have a nurled head or may be locked with a check nut. Whatever its form or arrangement, however, it is a poor expedient, and should be available only where a better device cannot be employed. This is shown in Fig. 3.

This scheme is, however, peculiarly valuable for gage points and clamping or securing screws. It is surprising how many individuals and concerns vitiate a good design and careful lay-out by careless preparation of parts and by resort to merchantable material in behalf of low cost. Gage points should be carefully made as well as bushings, and merchantable screws are not suitable for even mediocre work.

Fig. 4 shows one of several forms of jig and fixture screws employed by a concern that makes many special tools for various classes of work. The advantages are those of the last form of bushing indicated, namely: the screw is located and controlled in position by the long cylindrical tit, and there is no chance for chips to work into the threads.

I frequently wonder why there is such a diversity of fastening devices in use on special tools. While the bodies and clamps must assume a variety of shapes to accommodate the variety in shape and form of the pieces machined, there are certain elements like latches, clamp nuts, handles, gage and securing screws which are uniform at least in general form and which some manufacturers should be able to produce in quantity, accurately, at prices which would greatly discount the present cost of making individual pieces in the average shop.

Some contend that the conditions of

special-tool work are such that it would be impracticable, if not impossible, to produce a standard set or list of jig screws or other parts. The only difficulty lies in overcoming the proclivities of the tool designer, who frequently proportions his work by fancy rather than by system. There is no valid reason why a tool designer should not adapt himself to standard lists of tool parts as much as the designer of a machine to standard machine parts. There are concerns that enforce this principle, but a lot more who do not, either because they do not appreciate its benefits or because they do not feel warranted in incurring the expense of producing a supply of standard parts for special tools. Here is where the special manufacturer of such parts would come in. The tool designer of the small concern could select from the purchase list, just as he now selects pieces from a standard drop-forge list or from a bolt and screw list.

The articles recently published concerning the laying out and machining of special tools fill a felt want, for many pseudo toolmakers have no certain knowledge of methods necessary to secure accuracy within requisite limits in tool work; many tool draftsmen have little resource in designing special tools and so little sense of proportion that light jigs are provided with metal sufficient for fixtures, and fixtures with insufficient metal to hold a piece of wood for a saw cut.

An interchange of ideas on the principles of special-tool design and construction would appear more profitable than descriptions of specific unique schemes, and might help to inaugurate a system of standardization which should be of advantage among the various shops, rather than in any individual shop.

Central Falls, R. I. P. PRINCEPS.

## The Press Tools for a Small Tin Box

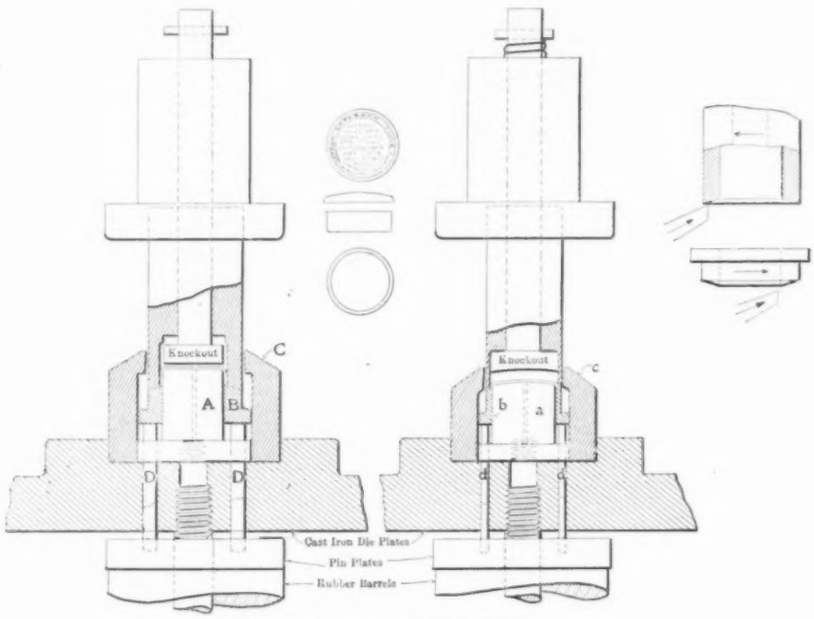
The press tools here described were designed to manufacture, in very large quantities, the small sample box shown between the dies in the accompanying illustration. The box was made of gold-lacquered tin plate and the cover of decorated tin bearing an advertisement of the medicine in addition to the ornamental design. The boxes were wanted in lots of 100,000 to 500,000, all to be exactly interchangeable so that covers left over from one lot could be used with next season's consignment and also for the reason that the manufacturer wanted to stock up on boxes so that rush orders would be confined to the covers, which were lithographed to suit various patrons.

Three main factors were considered in designing the dies: accuracy of product, life of the tools and simplicity of construction. As a matter of fact, no shine nor frills were put on the dies, so that the cost was as low as possible and several years' use has proved their construction very good. The outside diameter of the box was 0.925 inch, the thickness of lacquered stock 0.0105 inch, which makes the diameter of the center post $A$ 0.904 minus 0.001 allowance, or 0.903. The depth was ¼ inch and the diameter of the blank was found by using the formula

$$D = \sqrt{d^2 + 4\,d\,h}\,,$$

where $D$ = diameter of blank, $d$ = diameter of box and $h$ = hight of box, which gives the blank diameter 1.33 inches, also the size of the punch and cut edge $C$. It will be noticed that the fit between the cover and the box is made on a burred edge, or "mouth," as it is called, of the box which allows the drawing punch to wear considerably before requiring refitting; it also allows the die setter to make the fit by raising or lowering the press ram. The size of this mouth is 0.005; this added to the size of the box makes the inside diameter of the cover 0.930, which is also the size of the center post $a$. The thickness of the cover stock was 0.012, which makes the outside of the cover 0.954 plus 0.001 allowance, making the punch bore 0.955 inch. The 0.001 allowance is necessary so as not to mar nor strip the lacquer or printed design from the metal; more may be necessary because of the variable thickness of metal or coating, but the least amount is best, as the punch finally wears too large anyway. The only other sizes necessary to know are the stroke of the press and the gap or die space; when these are known, the dies can be sketched in. The closed position is the better, as then all factors are seen at a glance.

To make the dies themselves with the least expenditure of time and effort is as important as to design them without wasting stock or using difficult constructions. In this case the center post $A$ can be made from the bar, finishing the bottom outward and leaving a bit to grind on the flange, body and end, drilling the air vent and tapping a ⅜-inch hole for rechucking and then cutting off. After hardening and drawing to a pale yellow, the bottom is rubbed down on a lapping plate to a good surface and then screwed against a freshly faced piece in the chuck by means of the ⅜ tap hole above mentioned. The body and flange are ground exactly concentric, the end and round edge finished and well polished. The three holes for the pins $D$ and three tap holes for holding the post to the die plate had best be finished before hardening, though it is usual to leave the bottom soft enough to work.




THE TOOLS AND THE WORK

The ring $B$ is best made from the front or bevel end, making the bore a few thousandths over the finished size of the center post, leaving a grinding allowance on all other dimensions and cutting off. It is then hardened and drawn to a light brown. The bottom can be ground by wringing the ring on the center post as it is being ground down to size; the flange can also be ground at this time and the rest finished later by chucking a scrap piece, boring and facing a hole 1/16 inch deep and lightly tapping the ring in, or by soldering the ring to a freshly faced piece held in a "master" chuck. As for the cut edge $C$, it is best made from the front, boring nearly to size, counterboring large enough to clear the ring flange, yet small enough to allow another cut to fit to the center-post flange; the top is beveled to render frequent sharpening by grinding easier, and the outside left black or a cut taken over, as desired. After drilling and tapping the three holes to hold it down to

the die plate, it is hardened about halfway, drawn down to a light brown, chucked with a short bite near the bevel and trued by both ends of the bore; then the bottom can be faced, the fit bored a neat tapping fit to the center-post flange and the cutting portion ground out to size with a 3-degree taper. Later the cutting edge is sharpened by hand and a little shear given in three or four places.

In a large factory a lot of punch shanks usually accumulate from large punches that must be entirely replaced. These shanks can be used to hold the working parts of smaller punches, or in their absence the shanks can be made of machinery steel or iron, thus saving an initial cost of tool steel and a little time in the making. The shanks are usually held in a "master" chuck bored to receive a standard shank, which is also held by a set-screw, this chuck being bolted to a small face plate, which permits some adjustment. The working end of the punch can well be made of a good grade of unannealed tool steel, and it will be found that it will last nearly if not quite as long as hardened steel drawn down enough to permit upsetting by the die setters. Highly tempered punches are not much good on shallow single-action draws, as the cutting edge wears much faster than the drawing edge and cannot be upset without expensive annealing; another reason is chipped and too quickly dulled cutting dies.

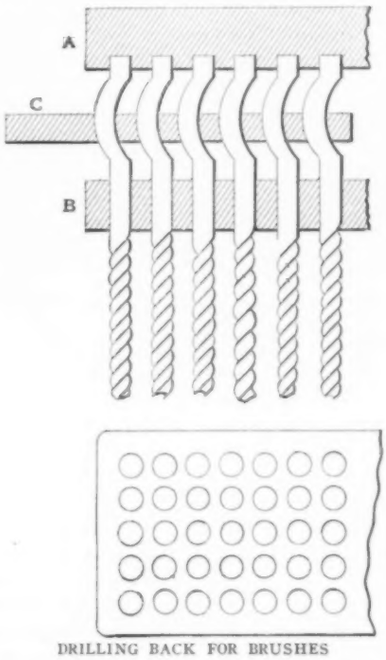
The bevel on the punch and ring can be as much as 15 degrees on 25 per cent. draws and up to about 30 degrees on more shallow work, which permits easier, frequent and more upsetting than the ordinary flat-end punch without materially affecting the draw, except on deep work. When working in this bevel, it is easier and more satisfactory to set the compound rest to the angle for the punch, turning and grinding the ring by running the lathe backward, as is shown in the side sketch; this is much more accurate and reliable than trying to set the rest to the opposite angle. This bevel should be lapped to the ring with flour emery and both bevels, drawing edge and punch bore well polished with worn-out emery or crocus cloth. The outside of the punch should be eased off about 0.005 inch to avoid excessive wear on the cut edge, leaving the land, about ⅛ inch wide, a good fit to the cut edge. Make this fit last, so as not to round the edge when polishing the bevel. The pins *D* should be large enough to stand the racket, loose in their holes and long enough to let the ring *B* come almost flush with the top of the cut edge; they should be shortened as the cut edge wears. They must all be exactly the same hight and be kept so by frequent attention; they are best placed directly under the working portion of the drawing ring.

Common pin gages are provided for properly spacing the stock. The boxes are cut from the sheet, but the cover designs are cut into strips, according to reference lines lithographed upon the sheet, each sheet having about 300 similar designs. The capacity of each die on a piecework basis was between 25,000 and 30,000 a day of 10 hours.

Springfield, Ill. W. SIRIUS.

## Drilling Closely Spaced Holes

I am interested in the illustration and description of the drill heads which you published on page 900, Part 2, Volume 30. It shows a very neat conception of the principle of operating adjacent cranks. While I do not wish to detract at all from the efforts of the maker of these drill heads, I could not help but recall a similar contrivance that I noticed at the American Institute Fair in 1872, which was held at the corner of




DRILLING BACK FOR BRUSHES

Sixty-third street and Third avenue, New York City.

I was a young shaver at that time, attending an exhibit, but I remember a brush-making concern having a small exhibit near me. They had a little brush-back drilling machine for drilling the wooden backs of brushes, all the holes at one time. The drills were bent on their shanks about as in the inclosed rough sketch. The two members of the head marked *A* and *B* were stationary, and the plate *C* had a rotary motion corresponding with the offset of the crank.

It was the first time I had ever seen this principle used and I have never forgotten it. I sometimes wonder if there is indeed anything new under the sun.

There was one exception, however, I remember. About 1870 a man started a restaurant in the basement of the New York *Sun* building. He had across the front a sign which read, "Something New Under the Sun," and it was never disputed to my knowledge.

Providence, R. I. GEO. H. SMITH.

## A Designer with the D T's Twisting Iron in a Pipe Machine

When I was a boy of 15, being of a mechanical turn of mind, I was sent to Chicago to work in a machine shop, oiling shafting, tapping nuts, threading bolts, grinding gates on castings, running errands for the foreman and giving a hand to anyone who needed it.

The foreman, Mr. R., was a man of German extraction, with a slight impediment in his speech, especially in the use of the letter T, to which he gave the sound of D. In other respects his English was quite good. One of his duties was to make detail drawings of fancy grilles; in pursuance of his duties he requested me to go up to the pattern shop and ask the foreman, Mr. L., to let me have for his use a D-square, as he called it. After climbing three flights of stairs (at the time not knowing there was an elevator in the building), and reaching my destination a little out of breath, the following conversation ensued:

"Mr. L., Mr. R. sent me to you to see if you would be kind enough to loan him a D-square for a little while."

"A what?"

"A D-square," I replied.

"Don't know what that is."

"Neither do I, but that is what he asked for."

"Well, you better go see what he does want."

I volunteered the information that Mr. R. said he had some D-tails to make; what that was was unknown to me at that time. But no D-square was forthcoming, so I went down to Mr. R. and told him that Mr. L. had no D-square.

He said, "Did you ask for a D-square?"

"Yes, sir; but he did not know what it was," I replied.

"That was not what I sent you for."

"But that is what you said," I expostulated.

"Donnevetter, no! I said a D-square, not a D-square," he replied in language more forcible than polite.

After several fruitless trips on my part, he had to go and get it himself, and he carefully drew my attention to the article so it would be recognized when needed again.

About a year after this incident a job came into the shop to make several hundred feet of iron fencing. Between the rails were numerous 5/8-inch square bars that were twisted spirally for about 2 feet. An attempt was made to twist them by heating them, catching in the vise and using a wrench to twist them with; but

it proved a failure, as the twist was not uniform. After a few had been so made I took the liberty of suggesting to Mr R. that they try to twist them in a large pipe machine which was standing idle at the time, and do it cold.

"Do you think it can be done?" he said.

Before answering him I got a piece of pipe that I had caught too far back when threading in a hurry; it had quite a twist in it. I showed it to him and said if the machine was strong enough to do that it would certainly twist a little thing like those bars. He looked astonished and said, "Well, your head is not as empty as it looks; go ahead and try it."

We took a piece of iron, wide and thick enough to fill the slide in which the die-holder went, drilled and filed a square hole a little larger than the bars, so they would be sure to go in, as they varied somewhat in size. We slipped it into place, then slid the head back so it was the right distance to give the length of twist wanted, and put a bar in, clamped one end in the chuck, threw in the back gears and put a chalk mark on the chuck nearest to the ways of the machine. Then we started up and counted the turns. When enough turns had been made, we stopped the machine, opened the chuck, pushed the bar clear through the spindle and examined it for flaws, Mr. R. standing by all the time. But there were no flaws; it was a beautiful job. After doing several more, the blacksmith was put on the job and completed it in a short time.

This occurred in the year 1885 and I had never seen it done before or since; but lately I have seen an article on the same subject in a recent number of the AMERICAN MACHINIST. The only difference is that the article mentions a bolt cutter as being used, while we used a pipe machine.

Vallejo, Cal. G. W. KORETKE.

## Converting a Lathe into an Internal Grinding Machine

What to do with a machine tool that has outlived its usefulness is a problem that confronts the management of every shop. Machine-tool builders are constantly improving their output and frequently it is good policy to replace a tool, otherwise in good condition, by one of a more up-to-date pattern. In such cases there are only three things to be done: Sell the old machine as a second-hand machine, scrap it, or make alterations that will again enable the machine to pay for its maintenance.

This article describes how a lathe of a bygone type was converted into a useful internal-grinding machine. Fig. 1 gives a good idea of the general scheme employed, showing a large shell in position to be ground. It will be noticed that the emery-wheel arbor is of large diameter, to prevent springing. For the same reason a heavy weight *W* is suspended from the arbor support. This will be found indispensable for giving rigidity to the arrangement. The general design for reversing the feed will be seen in Fig. 1, while Fig. 2 shows the feed-reversing mechanism more in detail. The letters used to indicate parts are identical for the same parts in Figs. 1 and 2.

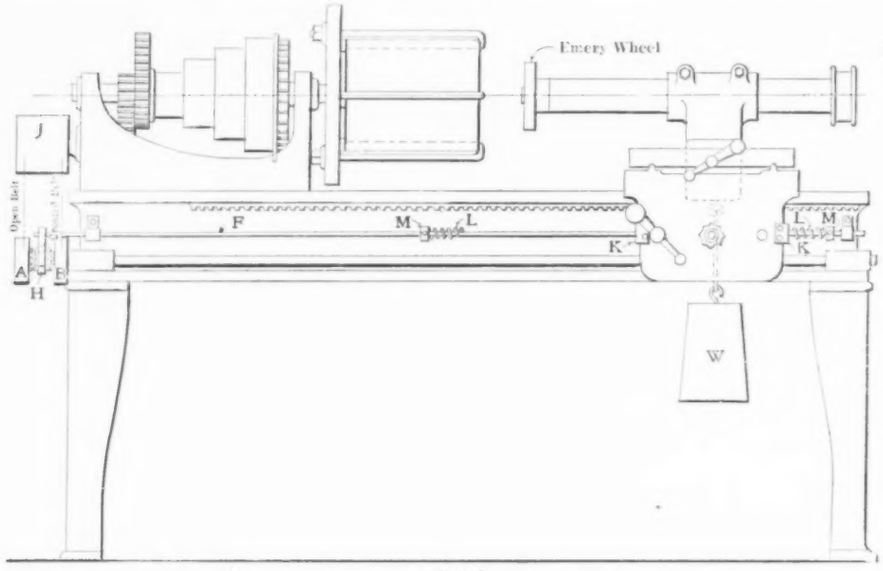



FIG. 1

LATHE CONVERTED INTO GRINDING MACHINE

Pulleys *A* and *B* are both loose on the feed shaft *G*, provided with proper collars to prevent end motion. They are driven in opposite directions to each other from pulley *J*. The inside hubs of *A* and *B* are provided with clutch jaws of the tooth pattern. Dog *H* slides on a key in shaft *G* between *A* and *B* and transmits motion to shaft *G* either way, according to which pulley it is connected with. The dog is operated directly by a clutch fork *C*, and indirectly through rod *F*. Fork *C* pivots on bracket *D*. Two straps *K* are fastened on either side of the apron and slide over rod *F* until they strike coil spring *L* and through them collars *M*, which are set-screwed to rod *F*. It is obvious that this will cause rod *F* to slide forward until the dog is pulled out of the clutch jaw it has been meshed with and reaches the neutral position shown in Fig. 2. The dog *H* is forced out of this dead position into the opposite clutch jaw by V-spring *E*, aided also by coil spring *L*.

This machine has been in successful operation for some time, doing accurate work. It is not to be expected that this makeshift machine can be compared to a standard-make grinding machine as far as ease of adjustment and adaptability are concerned; still a small outlay secured a tool that was found very useful for large work.

ED. E. EISENWINTER.

Brooklyn, N. Y.

## Mathematics in Engineering Education

On page 960, Vol. 30, Part 2, I read with interest and approval the criticism of the methods of teaching mathematics to engineering students. In that article exception was taken to the fact that the ordinary professor of mathematics teaches the embryo engineer his mathematics as an end in itself, rather than as a means to an end. While this, I believe, is the method pursued very largely, I wish to call your attention to one shining exception. I refer to the Co-operative Engineering Course in the University of Cincinnati.

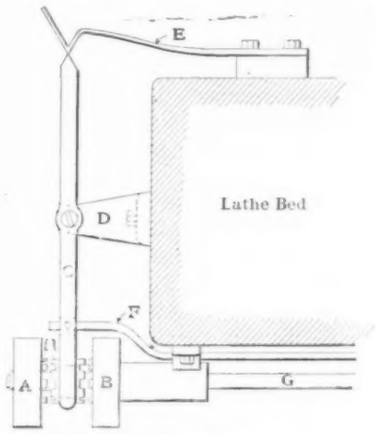



FIG. 2

DETAILS OF REVERSING MOTION

As you will remember from previous descriptions, this co-operative course is run on an alternate week basis. The students are worked in pairs, each student spending a week at the shop while his alternate is at the university and *vice versa*. The fundamental idea of this course is to make it as practical as possible. On entering the course the students are advised

to be sure that they understand the practical application of every lesson they get. The instructors are also impressed with that idea, so that whether it is mathematics, physics, or any other subject, if the instructor does not first explain the practical application of the problems he expounds, some student is sure to ask him where and how he can use the formula, problem or theorem in the business of engineering. Then it is up to the professor.

The instructors in mathematics are themselves engineers and not pure mathematicians, so that this idea works out to the eminent satisfaction and practical advantage of the students, the instructors and employers of these students. The text books and courses have been revised with this idea in mind and all matter that had purely academic interest was eliminated.

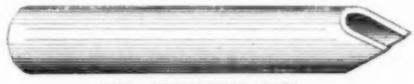
It occurs to me that if the engineering students generally could be trained or tipped to ask where they can use such matter in business, employers would have less cause for complaint as to impractical training of technical graduates, and graduates themselves would derive more benefit from their engineering courses. Incidentally, this is only one of the many reasons why we believe that they are making the very best and most valuable kind of engineers in the co-operative course in the University of Cincinnati.

E. F. Du Brul.

Cincinnati, Ohio.

## The Slocomb Micrometer Adjustment

The description, at page 953, Vol. 30, Part 2, of a device for rescuing the tension nut of a Slocomb micrometer is interesting as showing a difficult and bad way of doing something that should never need to be done.



THE ADJUSTING TOOL

Some years ago it chanced to be my lot to watch over a large number of Slocomb micrometers; replacing the tension nuts was a task of frequent occurrence, which speaks very forcibly for the lack of intelligence of the workmen.

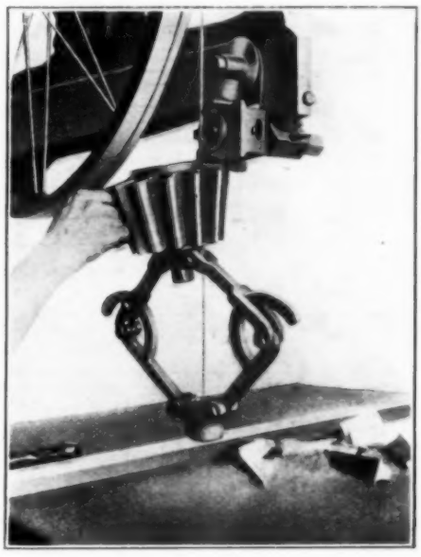
Slocomb micrometers owned and used by me for the past 11 years have never needed their tension nuts removed from the bottom of the thimble, and probably never will till someone "monkeys" with them.

We use a piece of brass wire bent like a hair-pin and V-shaped at the points. Then one of the boys improved on this by cutting off a 3-inch long piece of brass tubing of proper inside and outside dimensions, and forming it on one end as shown in the line cut. Ten minutes more than covered the time to make this nut rescuer.

Chicago, Ill. W. S. R.

## Adjustable Attachment for Sawing Bevel Gear Teeth

Considerable amount of discussion has taken place in various mechanical journals from time to time on the subject of forming bevel-gear wheel patterns on the band saw by a jig in the form of a ball-and-socket section. Nothing, however, has been said, so far as I know, concerning an adjustable jig, which may be used in sawing out the teeth of wheels of various sizes and angles. In the accompanying half-tone I present a method by which this can be successfully accomplished and trust it will be of interest.



ADJUSTABLE ATTACHMENT FOR SAWING BEVEL GEAR TEETH

The method is here shown on the band-saw table in operation. The jig proper is operated on a ball, with the cutting edge of the band saw passing through its center, and can be raised or lowered as the case may be, to obtain the desired angle by pivot points and set-screws, and is attached to the gear-wheel pattern by a revolving pin.

It is, of course, necessary to use a little care and precision in operating this jig, but by its use not only a quick and accurate job can be turned out, but an appreciable saving in time and material can be effected.

A patent on this band-saw attachment has been applied for and it is the intention of the inventor to put it on the market in the early future.

Columbus, O. Allen E. Owen.

## Are Scraped Bearing Surfaces Necessary?

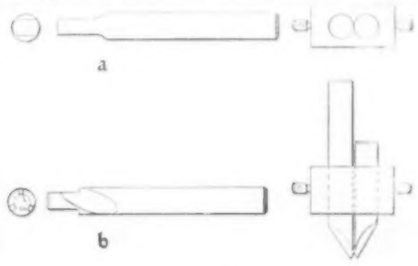
The editorial article at page 960, Vol. 30, Part 2, on scraped surfaces, prompts me to "speak out in meeting" concerning a class of scraped surfaces that you do not mention; that is, round bearings. Of course, the greater part of present-day machinery has no such scraped bearings, this degree of refinement being carried out only on high-grade work, and it is doubtless a good thing for the important journals of fine machine tools, measuring instruments and other instruments of that class.

Still I know of machine shops where all round bearings, as well as flat ones, must be accurately scraped to fit, and so closely is this done that after a machine has been finished the placing of a chip under one corner will cause the bearings to heat and seize; there is no room in them for oil. When such machines are placed on ordinary floors the placing or removing of their product about them will have the same effect as a chip under a corner. Now while I have a great regard for scraped surfaces in their place, it has seemed to me that to put them at great expense on machines of this class—which are for rough, heavy work, in the hands of unskilled labor—is a worse than useless refinement. After they have heated, seized and been repaired, the bearings are far inferior to a good reamed and filed journal.

New Britain, Conn. D. C. Howard.

## Drifting Holes

The broach shown by Mr. Ermon on page 809, Vol. 30, Part 2, is apparently intended for heavy work such as very large dies, manholes in boilers, etc. For ordinary die work the form of broach or drift most generally used is that shown at *a*, which is easier to make and leaves less stock for filing. The width of the flats on this broach should be about the same as the distance from center to center of two adjoining holes and the thickness should be about 1/32 inch less than the diameter of the holes. It should be about 0.005 back tapered and the flatted part long enough to go more than half way through the die so that when it is broached from both top and bottom the center will come out. Where it is convenient it is better to drill the holes about 3/4 the size desired, drilling the holes as close together as possible and then counterbore to full size. This will cut out the bridges but if a couple of holes on each side are left blank until afterward a broach as thick as the diameter of the holes can be used to cut out the points left and leave hardly any filing. It usually happens that the size of




DRIFTING HOLES

counterbore desired is not standard and the quickest way to make one is to turn up the blank and flute it in three places with a round file. A counterbore of this kind as shown at *b* cuts more freely and nearer to size than the regular style. A convenient punch for laying out the holes without first scratching the distance between centers is shown at *c*. By loosening the set screws and turning the punches any distance between centers can be obtained from 1/16 inch to 1/16 inch less than the sum of the diameters of the punches.

Hartford, Conn. JOHN A. EARLY.

## An Automatic Screw-machine Countersinking Tool for the Back of Nuts

Referring to the article by M. E. Chase, on page 458, on a back countersinking tool for nuts, he says: "The hole for *D* must be true with the shank, so that the tool *F* will be in line with the hole to be countersunk; otherwise the tool will require filing thus weakening it ———."

Now I have used this kind of tool on Brown & Sharpe automatics and have met with the difficulty which he describes, although I had an adjusting screw *H*, see Fig. 1, at the base of *A* where *B* comes in contact with *A* when at rest. This gave me a little adjustment but was not sufficient and was rather difficult to get at, as it necessitated taking the holder from the turret. The following addition was made to make this a real time-saving tool.

Referring to Fig. 1, the body *A* was made shorter and the slot wider; *B* was made in two parts, pivoted at *C*, and the part *C* was clamped to the main part *B* through two elongated holes *F F* by two set-screws which allowed for a great deal of adjustment.

Then the deflector, Fig. 2, is made in two parts and is adjustable as shown; *A* is the section which is clamped to the tool post and has a stud riveted at *B* which carries the adjusting screw *C*. The top plate *D* is pivoted by the screw *E*, its end coming against the screw *C*. The method of adjusting is simple: Slacken the screw *E* and adjust with the screw *C*, keeping the end of *D* in contact with it. Then tighten the screw *E*.

Perhaps M. Chase may think that this is carrying things a little too far and that the expense is too great. If the tool is to be a time saver let it be so, for it is judged by results and not by paper estimates. A little trouble with this tool alone will take up more time than the 10 per cent. difference between gross and net output. Mr. Chase says he has used this tool on Brown & Sharpe, Herberts, Pratt & Whitney and Simplex automatics but I fail to see how he can use this tool on the Simplex machine. If it is not asking too much, I should like to have him give the necessary information for using this tool on the Simplex.

L———, England. J. V. H.

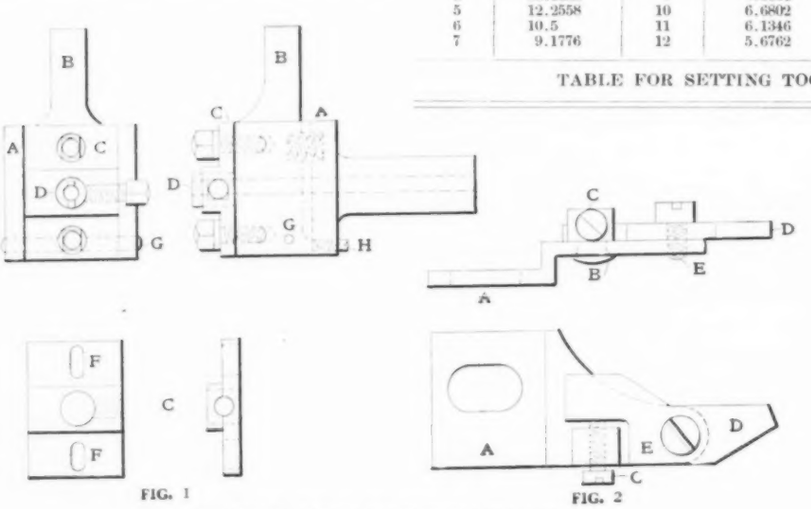


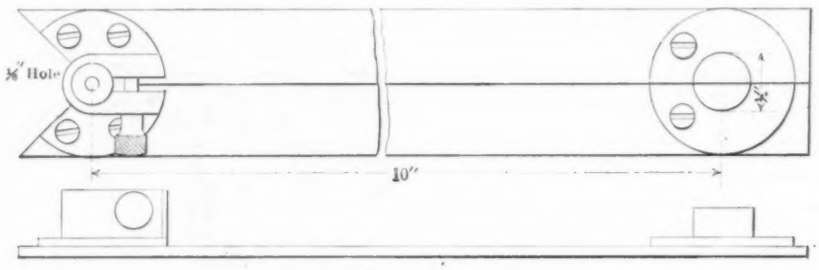

FIG. 1 FIG. 2

AN ADJUSTABLE BACK COUNTERSINKING TOOL

## Tool for Laying Out Angles

At page 787, in the article on "Trigonometry in the Tool Room," it is stated that there is no convenient tool for laying out angles with precision. For a number of years past I have had considerable experience on United States Government work, with the complicated drawings furnished to work from. I devised and made the bevel gage here shown about half size. In using this gage set a vernier caliper or large "mike" to twice the sine of half the angle desired, multiplied by ten, add one-half inch and open the gage till it fits the vernier; you will have the angle within the limits of the measuring tool and the radius of the gage. The eighth-inch hole in the center is for a setting plug when it is desirable to lay out an angle from a given center.

The table gives the measurements over the half disks required for setting the arms of the gage to give any angle from 1 to 45 degrees, and also the setting for any number of holes in a circle from 3 to 22; the latter feature, of course, is of service more particularly for work




TOOL FOR LAYING OUT ANGLES

GAGE SETTNGS FOR EVEN DEGREES.

| Angle Degrees. | Measurement Over Disks. | Angle Degrees. | Measurement Over Disks. | Angle Degrees. | Measurement Over Disks. | Angle Degrees. | Measurement Over Disks. |
|---|---|---|---|---|---|---|---|
| 1 | 0.6746 | 12 | 2.5906 | 23 | 4.4874 | 34 | 6.3474 |
| 2 | 0.8490 | 13 | 2.764 | 24 | 4.6582 | 35 | 6.5142 |
| 3 | 1.0236 | 14 | 2.9374 | 25 | 4.8288 | 36 | 6.6804 |
| 4 | 1.1980 | 15 | 3.1106 | 26 | 4.9980 | 37 | 6.846 |
| 5 | 1.3724 | 16 | 3.2834 | 27 | 5.1690 | 38 | 7.0114 |
| 6 | 1.5468 | 17 | 3.4562 | 28 | 5.3384 | 39 | 7.1762 |
| 7 | 1.7210 | 18 | 3.6286 | 29 | 5.5176 | 40 | 7.3404 |
| 8 | 1.8952 | 19 | 3.8010 | 30 | 5.6764 | 41 | 7.5042 |
| 9 | 2.0692 | 20 | 3.9730 | 31 | 5.8448 | 42 | 7.6674 |
| 10 | 2.2432 | 21 | 4.1448 | 32 | 6.0128 | 43 | 7.830 |
| 11 | 2.4170 | 22 | 4.3162 | 33 | 6.1804 | 44 | 7.9922 |
| | | | | | | 45 | 8.1536 |

GAGE SETTINGS FOR HOLES IN A CIRCLE.

| No. of Holes in Circle. | Measurement Over Disks. | No. of Holes in Circle. | Measurement Over Disks. | No. of Holes in Circle. | Measurement Over Disks. | No. of Holes in Circle. | Measurement Over Disks. |
|---|---|---|---|---|---|---|---|
| 3 | 17.8206 | 8 | 8.1536 | 13 | 5.2864 | 18 | 3.9730 |
| 4 | 14.6422 | 9 | 7.3404 | 14 | 4.9504 | 19 | 3.7918 |
| 5 | 12.2558 | 10 | 6.6802 | 15 | 4.6582 | 20 | 3.6286 |
| 6 | 10.5 | 11 | 6.1346 | 16 | 4.4018 | 21 | 3.4808 |
| 7 | 9.1776 | 12 | 5.6762 | 17 | 4.1750 | 22 | 3.3462 |

TABLE FOR SETTING TOOL FOR LAYING OUT ANGLES.

which does not require the accuracy obtainable by means of a dividing head.

WALTER T. DILLAWAY.

Hamilton, Ont.

## Cutting V-Threads by Feeding at an Angle

As several of the correspondents of the AMERICAN MACHINIST have discussed this subject, it may not be amiss to call your readers' attention to the fact that one of the advantages I claimed in the AMERICAN MACHINIST for the compound rest I designed, built, and described several years ago, was the ready accomplishing of this diagonal feeding, or in other words feeding so as to remove the stock all from one side of the thread, with its other advantages. In this connection it may not be amiss to call attention to another feature our boys at the Artisan School are using, and that is threading tools ground as shown in Fig. 1.

When one comes to think of it, what is the sense of making a tool like Fig. 2, so as to thread up close to a shoulder, when one like Fig. 1 does the same thing in a much more simple way? And any kind of a rake that the workman desires can be given to the cutting end.

All lathe hands have for years accomplished the cutting of V-threads by taking the chip first from one side and then the other by hitting the tool a rap first one way and then the other, but this feeding direct at an angle was first described, I fancy, in describing the compound rest

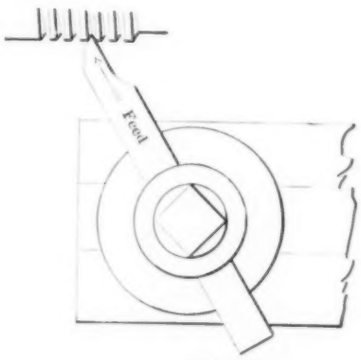



FIG. 1

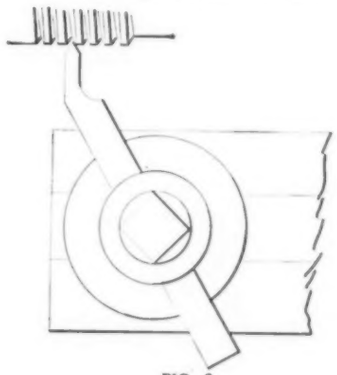


FIG. 2

TWO FORMS OF THREAD TOOLS

above mentioned. Of course it may have been done, as it is easy to do with any compound rest; but with the angle compound rest it is a natural thing to do.

There are lots of funny things in mechanics, and one of the funny ones is that people will not take a good thing unless it is patented and sold to them, or unless it is something they can steal. It has been possible to get lathe builders to put on 30-degree angle compound rests to secure the orders, but they neither advertise nor recommend them, as they say it takes too much talking to sell another man's ideas.

Syracuse, N. Y. JOHN E. SWEET.

[This shows the same sort of a tool as was described in an article at page 58 of the Jan. 9 issue. The present article, however, was received previous to publication of the former one.—ED.]

## An Undercutting Tool

In connection with the illustration of the automatic machine built by the G. G. Prentice Company, New Haven, Conn., which recently appeared in the AMERICAN MACHINIST, I submit the following description of an undercutting tool that was made for use in one of the smaller three-spindle, single-end machines.

In the sketch of the work the outer ball, which is sectioned for clearness, shows the operation that was to be done: rough ream, undercut the groove and finish ream.

The work was first drilled through in a drill jig to a size a little smaller than the small end of the taper.

It was then taken to the Prentice machine, which was equipped with false jaws to hold the work.

The first spindle held a roughing taper reamer which enlarged the hole nearly to size. In the second spindle was the undercutting tool, the action of which will be explained later, and the third spindle held the finishing reamer which finished the hole to gage and removed all burs left by the undercutting tool.

The tool, Fig. 1, consists of a body *c*, a pivoted tool carrier *d* and a sliding collar *e*. The rear end of the body was threaded, as shown, to screw onto a special spindle.

The front end was slotted 7/16 inch wide across the end to a depth of about 1¼ inches, and in this slot the tool carrier *d* was pivoted upon the stub, as shown.

The rear end of the body was also tapped at *g* for a headless screw which backed up a stiff spiral spring, which in turn operating upon the pin *h*, kept the tool carrier in a central position as governed by the collar *e* and stop pin *j*.

The tool carrier was bored out in front for the tool holder proper, a section of which is shown at Fig. 2. The holder consists merely of a shank and head, the shank being tapped axially for a headless screw, which screw, bearing upon a bevel-ended pin, clamped the cutting tool in position.

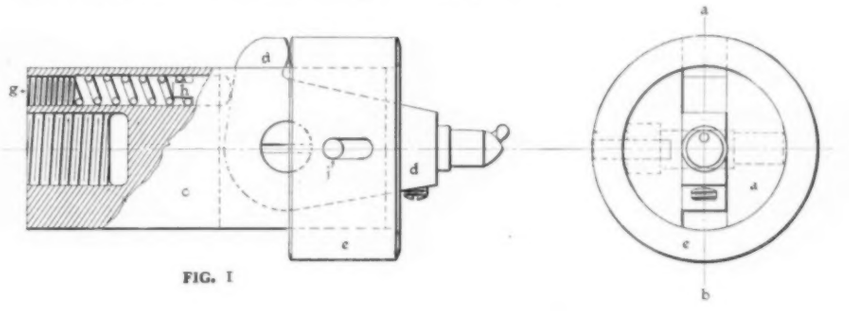
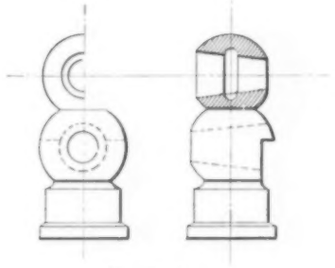



FIG. 1

Section on a-b of Tool-holder

FIG. 2

AN UNDERCUTTING TOOL



The Work

The collar *e* is hardened and left as hard as possible and the hole ground and lapped a nice sliding fit on the body.

The tool carrier *d* is also hardened at the point which bears upon the collar.

The means of operating the tool was a cam which was bolted to the periphery of the drum that is situated directly under the working end of spindles, the cam being located so as to strike the front end of collar *e* and force it back at the proper time, which was when the chuck had nearly reached the end of its forward travel.

As soon as the cam passed the collar, the spring behind the tool carrier pushed it ahead, withdrawing the tool from the groove ready for the chuck to back off.

The shape to which it was necessary to grind the cutting tool to produce the right-shaped groove had to be found by experiment on account of the short radius at which the tool was fed into the work.

The quantity of the output from this tool was all that could be desired.

Hartford, Conn. RAYMOND GROUT.

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## Wanted—A School of Toolmaking

It has been the uniform experience of trade and other schools established for apprentices and other beginners in the trades that their advantages are made use of to a surprising extent by men of mature years, whose needs were considered but little, if at all, in the original plans. This was brought out forcibly at the recent industrial educational convention at Chicago, and another instance not there related, but which has since been noted in these columns, is that of the Winona Technical Institute at Indianapolis. The uniformity of this experience leads to the idea that the needs of adults should be considered in the organization of the schools.

The Winona institute has already secured the necessary equipment for a school in machine-shop work, and it would seem to us eminently appropriate that while the purpose of that school to provide for the beginner should be adhered to, it should, nevertheless, take up more advanced work and provide systematic instruction in tool-making.

The workman in the shops has two avenues of advancement open to him, one to foremanship and work in an executive capacity, and the other to the tool room and immediate charge of manufacturing methods as distinguished from authority over the working force. There is no doubt that this latter field appeals to many through the positive argument that their satisfaction with their work is obtained through the accomplishment of results by their individual skill or through the negative argument that they are not by nature fitted for an executive position. To such men a school of tool-making would, we believe, prove a magnet, and there is no phase of machine-shop work which is more appropriate to systematic instruction.

Some of the articles which have appeared in our recent numbers point out in a small measure the scope of the instruction to be offered. The locating of holes in jigs, the use of the microscope, making index plates, lapping, the possibilities of the fly-cutter, the camming of automatic screw machines, the treatment of steel and other subjects connected with manipulative skill, such as the use of the measuring machine and the making of gages, form a range of subjects appropriate for systematic instruction. With the aid of modern furnaces and pyrometers the treatment of steel is rapidly becoming an exact science, and to these the study of fractures is about to be enormously advanced by the use of the microscope. A hardening room—we suppose the catalog would call it a laboratory—properly equipped would enable one to acquire more definite knowledge of the proper treatment of steel in a few weeks than most men acquire in half a lifetime. Such a school would also naturally include work on tool and fixture design wherein, with the aid of a competent teacher, the most useful imaginable results might be obtained.

The difficulty of providing a suitable product which confronts other trade schools, would be very much simplified in a school of tool-making. One of the serious difficulties connected with manual-training schools in general, is that it is impossible to secure the interest of the student in work which is to have no value when done, but this difficulty would be absent in a school of tool-making. Its students would have acquired the commercial spirit before entering it, and would have no need of the stimulus of commercial work. On the contrary, they would welcome the opportunity to do the best work of which they are capable for the mere gratification of so doing. We can imagine no more interesting work for machinists than the hardening of sample pieces of steel with the appliances mentioned above, and subsequently testing them out for hardness with Mr. Shore's scleroscope, which was recently described in these columns and studying their fractures with a microscope. Moreover, the expense of material would be comparatively small, as there is no kind of work in which the cost of material compared with the expenditure of work is so small as in tool-making. Another feature which should not be lost sight of, is that such a school would appeal to those who have already acquired good earning powers and who could afford the expense of attendance, which most young boys cannot.

So far as filling a want is concerned, such a school would be just as useful as any that can be named. Prior to the recent panic there was no class of men more in demand than capable toolmakers. We have, indeed, heard of one instance in which a manufacturer contemplated starting just such a school as we have described in order to train men whom he could not find. The effect of the school on the general welfare would, we believe, be far in excess of that of an elementary school. All that an elementary school can do is to train boys to serve as one of the rank and file, its influence on manufacturing industry being measured by the number of boys so trained. A school for toolmaking would not only supply toolmakers, but it would do much more, as, if made of the high grade that it should be, it would become a center of influence, and through its graduates spread a knowledge of advanced methods and practice throughout the country.

We believe there is no more useful or promising line of work which the Winona Institute can take up than this, and we hope to see something done about it.

## Shop Equipment in Times of Manufacturing Inactivity

In every factory organization there is some one whose duty it is to care for the plant. Power must be available when the starting-up time comes around and must be continuously supplied throughout the hours of working; light must be available when wanted; there must be a proper drinking water supply; heat is necessary during the winter months and there are many other factors which enter into the operation of a manufacturing plant and which are classed under the general head of factory equipment. Men in charge of such details usually have a number of repair jobs planned as over-time work. Very often there are shafts to be relined and releveled, pulleys to be reset, leaking steam pipes or other pipes to be tightened, valves and joints to be repacked and a multitude of small details to be looked after of such a nature that they must be done when the factory is idle. Sundays, nights, holidays and shop vacations, if any are granted, are the times when a certain number of men work their hardest.

It needs no argument to prove that work done under such conditions, over-time work as it is usually styled, must cost more in proportion than similar work done in regular working hours. In many shops it is customary to pay a bonus for such work as time-and-a-half or double-time. This directly increases the expense as well as the fact that men cannot work to as good advantage at night or under conditions much different from the normal. Their production per unit of time is greatly reduced.

These facts should be thoroughly appreciated in times of manufacturing inactivity. If for any reason the regular working hours are shortened an excellent opportunity is afforded for repairs and upkeep work on plant and equipment. Such an opportunity exists in many places today and it is the part of wisdom to put every physical detail of a factory into the best of condition at a time when it can be done more inexpensively and to better advantage than usual, and thus be prepared for the business activity which will surely come.

While we have dwelt on the features of repair work, rather than new construction work, still additions to the equipment can be installed with as great a benefit. Governing considerations in the one case apply equally as well in the other.

Saving of time, labor and expense in upkeep work can be paralleled in the case of new constructian. Thoroughly executed repairs are no more of a necessity when business begins to hustle than proper additional equipment. Both are important and each should receive the consideration which is its due.

## The Gas-power Section of the A. S. M. E.

Following the lead of the Franklin Institute and other engineering societies, members of the American Society of Mechanical Engineers have organized a gas-power section for those interested in this line. This section welcomes all who are interested in gas power in any form whether members of the parent society or not, invites papers and discussion from any source.

The first meeting of the new section was held on February 11 at the Engineering building, with H. H. Supplee presiding and Professor Lucke as secretary. The first paper was on the gas calorimeter by the secretary, and pointed out the advantages of buying gas, as well as coal oil or other fuels by the heat units rather than by the cubic foot, ton or gallon. He considered the calorimeter as being to the gas engineer what the steam gage is to the steam field.

Mr. Supplee showed a number of illustrations of gas turbines, beginning with the old "smoke jack" of 1680, which was used above the fireplace to turn the roast on the spit, and coming down to the latest designs, which claim an efficiency of 62 per cent. The first gas turbine of record, and that probably never got beyond the paper stage, was in 1791.

Mr. Chatain, of the General Electric Company, described some of the details of their new gasolene railway car in which the transmission mechanism is a dynamo and motor as in the Heilman locomotive in France some years ago. The car weighs 3920 pounds, has an eight-cylinder engine of 125 horse-power, and drives by varying the potential of the generator. The cooling is by thermo-siphon circulation and is believed to be the largest installation of this in use. The engine is started by a cartridge containing 300 grains of black powder, one cylinder being fitted with a breech block for this purpose. The consumption averages one pint of gasolene to the horse-power, and the car is driven 2½ miles per gallon of gasolene; its maximum speed is 55 miles per hour.

Professor Lucke also read an interesting paper on gas-engine guarantees, which should tend toward having a regular form that will mean more than is generally the case. The attendance at the meeting seemed to indicate a need of such a section and its promoters should feel gratified at the result.

## New Publications

DRAFTING, VOL. 1, NO. 1; 52 6½x10-inch pages; monthly. The Inland Publishing Company, Cleveland, Ohio. Price, $1 per annum.

A new periodical has entered the field of technical journalism under the title given above, which will bring to mind the journal, *The Draftsman*, whose lineal descendant it really is. Its first issue has a good list of contributors, among whom are several whose names are familiar to readers of articles on drafting and allied subjects. Three of its divisions of subjects are General Subjects, Engineering Review and Shop Knowledge. These seem to be well selected with, however, a little over preponderance of space devoted to the second class. They promise to treat of the draftsman's needs in a very practical way. Two other features should be mentioned, The Data Sheets and The Evening Class. Four data sheets are in this first number devoted to: Proportions of ball cranks, topographical signs, horse-power of belting and shafting, and horse-power of gears. They are printed on stock resembling tracing paper and so can be blueprinted. The Evening Class takes its first lesson in simple arithmetic under the caption, "Problems in Shop Mathematics," and tackles the design of a gas-engine crank case after a brief lecture under the title of "Machine Designing." The instructors of these two sections are H. J. Thiede and Prof. A. Edward Rhodes, respectively. The editorship is held by W. D. Browning and the data sheets are in the hands of F. G. Walker.

## Personal *

Louis Fulton, of the Waterbury Farrel Foundry Company, sailed from New York on a two months' business trip abroad.

H. P. Townsend has joined the organization of the E. J. Manville Machine Company, Waterbury, Conn. Mr. Townsend was formerly connected with the Corbin Cabinet Lock Company.

O. W. Plaut, until recently in the employ of the T. A. Mack Company, of Jersey City, has accepted a position with the Rochester Optical Company, of Rochester, N. Y., and for the present will devote his time to the design of a special automatic machine.

C. F. Harding has been appointed head of the School of Electrical Engineering of Purdue University. Professor Harding's extensive business experience and broad practical training, together with his former experience as associate professor of electrical engineering at Cornell, equips him in an unusual degree for his new position.

W. F. M. Goss was formally installed as dean of the College of Engineering of the University of Illinois on February 5. The exercises consisted of two sessions and included a trip through the laboratories of the university. The customary addresses were delivered by prominent men, the dean's subject being, "The State College." Many representatives of scientific bodies and railroads were in attendance, as well as members of other universities and a large delegation of the alumni.

*Items for this column are solicited.

# Standardizing Machine Spindles and Arbors

By Frederick Oyen

A weak point in commercial arbors and drill shanks is the method of driving by a tang. That this is not generally recognized as a weak point may be seen from the following rather amusing occurrence from life:

A prominent engineer, having had experience with drill tangs breaking and causing trouble in general, went to see one of the leading twist-drill manufacturers in regard to this. The superintendent of the concern, in discussing the matter, assured him that the tang was "merely a bluff," that the driving was really done by friction only and that they never experienced any trouble of that kind. However, fate was most unkind to the superintendent, a complaining shop foreman appearing just at that critical moment, carrying in his hand a twist drill with a broken tang, thus actually proving the engineer's point and settling the argument.

In the following is described a method of driving arbors by a "Barth key" instead of the tang. The idea of using a key instead of a tang is not new, Wm. Sellers & Co. having done this for years on their horizontal boring machines.

The method here described (which I will, for brevity's sake, call the "key method") was introduced at the Link Belt Company, Philadelphia, in 1903, by Carl G. Barth.

Fig. 1 shows the standard reducing sockets, Fig. 2 the standard adopted for shanks for arbors, drills and boring bars, also the standards for lathe centers. Fig. 3 shows the standards for the Barth key. These standards were originally intended for drill presses only, but later other machines were included.

Most of the drill-press spindles were already provided with No. 4 Morse taper; very few had the No. 5 taper, and a couple of machine spindles with smaller taper were reamed out to No. 4 taper, this taper being selected as a base.

The three smallest sizes of reducing sockets are made with No. 4 Morse taper outside and No. 1, No. 2 or No. 3 Morse taper inside. The large size, No. 4 reducing socket, is made with No. 4 Morse taper inside and No. 5 Morse taper outside. All reducing sockets have the Barth key dovetailed inside and a similar keyway outside. Shanks for arbors, drills, etc., are made similar to the reducing sockets. Thus No. 1 shank has No. 1 Morse taper, keyway for No. 1 Barth key and fits into No. 1 reducing socket; No. 2 shank has No. 2 Morse taper, keyway for No. 2 Barth key and fits into No. 2 reducing socket, etc. All the drill-press spindles are provided with a Barth key, dovetailed into the spindle as shown in Fig. 4.

The majority of the tapers in the headstocks and the tailstocks of the lathes were reamed out to No. 4 Morse taper, a few larger ones to No. 5. All the tailstocks were provided with a key, as shown in Fig. 4, enabling us to use any size drill in the tailstock of any lathe.

All lathe centers are made as shown in Fig. 2, keyways being milled in all of them. All the drill shanks (excepting drills smaller than 7/16 inch) are made according to the same standards, also drill chucks, tapping mechanisms, shanks for special tools, etc.

In buying new machinery, the Link Belt Company invariably makes out specifications to be sure that the machines bought will conform to the shop standards. Thus a new horizontal boring machine was bought with No. 5 Morse taper and No. 5 Barth key in the spindle. A set of boring bars was made as shown in Fig. 5, including all between. This is an illustration of the economy and simplicity of this method. The same drift will do for any machine for driving out the drills, arbors, etc., as all the slots are made 5/16 inch wide both in the spindles and in the reducing sockets.

The only drawback to the key method lies in the fact that the tapered holes cannot be re-reamed after the key has been put in. However, such re-reaming is only necessary where the spindles have been abused, and the most frequent abuse is

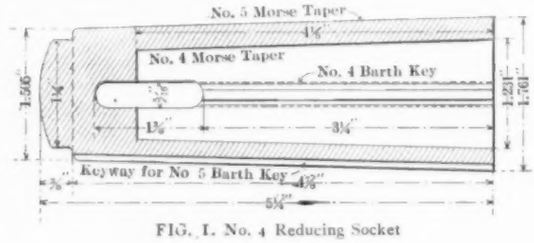


FIG. 1. No. 4 Reducing Socket

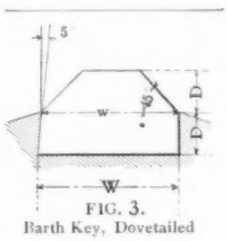


FIG. 3. Barth Key, Dovetailed

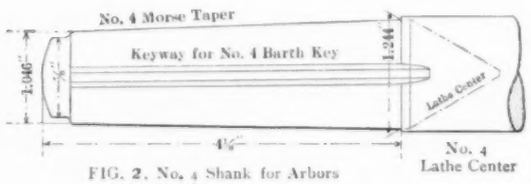


FIG. 2. No. 4 Shank for Arbors

No. 4 Lathe Center

| No. of Key | Number of Morse Taper in which used | w | W | D |
|---|---|---|---|---|
| 1 | 1 | 1/4" | .132" | 5/128" |
| 2 | 2 | 5/32" | .165" | 3/64" |
| 3 | 3 | 7/32" | .199" | 1/16" |
| 4 | 4 | 9/32" | .264" | 5/64" |
| 5 | 5 | 5/16" | .329" | 3/32" |

A STANDARD SPINDLE WITH BARTH KEY

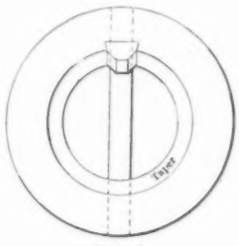
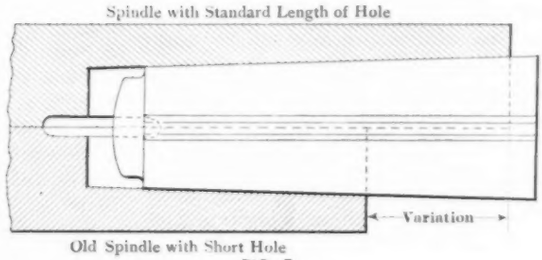


FIG. 4



Old Spindle with Short Hole
FIG. 7

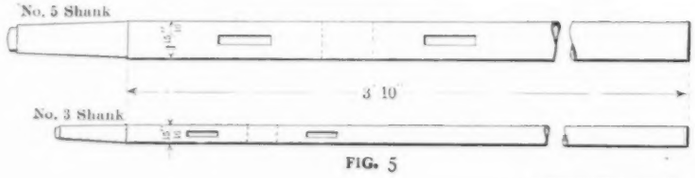
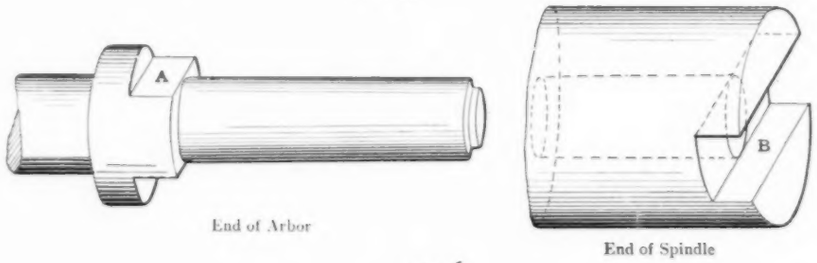


FIG. 5



End of Arbor
End of Spindle

FIG. 6

STANDARD SPINDLES FOR MACHINE TOOLS

that of putting a set-screw in the spindle to drive on the shank of the drill or arbor. It is very evident that with the key method there is no occasion for this practice which is so disastrous to the spindles.

A method different from the above described has been advocated as being cheaper, viz., "the slot method." This consists in swelling out the arbor and milling two flats *A* across it, as shown in Fig. 6. The spindle is slotted correspondingly, as at *B*.

At first glance this slot method may appeal to one as being cheaper, because a slot can be cut in the spindle at less expense than dovetailing a key. Taking into consideration, however, the time it takes to remove the spindles and put them back again, which on some machines may amount to a great deal, the difference in cost will be found comparatively small, and this work is done once only.

It is also apparent that a system of reducing sockets for the slot method would be very cumbersome, unmechanical and expensive.

Referring to Fig. 7, the key method possesses another advantage over the slot method, that of flexibility; this is a most important factor in a shop where a large number of machines of different makes and types have accumulated during many years, as the spindle tapers in such a collection of tools are certain to vary a great deal both as far as length of taper and amount of taper per inch are concerned.

It is safe to say that by adopting the key method *all* the machines in a shop may be brought to a standard in regard to spindle tapers, without making new spindles.

For horizontal boring-machine bars the slot method prohibits itself, as the bar must pass through the cored or drilled hole which is to be bored, before it can enter the spindle. As it is highly desirable to use bars of as large diameter as possible, a plain bar tapered down at one end is the ideal boring bar; this is made possible with the key method.

The only machines to which the slot method lends itself readily are milling machines, which are often made this way by the manufacturers.

In conclusion I wish to lay stress on the fact that before attempting to do anything along the lines indicated, all the spindle tapers should be carefully measured and laid out on paper, and a thorough study made of the whole situation before any work is done in the shop. The writer knows of a case where an offhand statement from a man who probably never gave five minutes' thought to the problem caused a very unwise course to be taken.

It is possible, of course, and highly desirable in a shop having a number of milling machines with the same spindle taper but with different taper from the rest of the machinery, to use the slot method for the milling machines and the key method for the rest. In the average shop, however, the one method advocated will prove the easiest, most satisfactory and in the long run the most economical remedy for tang troubles.

## Vanadium in Cast Iron *

By Dr. Richard Moldenke

As vanadium has given some valuable properties to steel it is but natural that attention should be drawn to its use in cast iron.

In order to learn something of the effects of vanadium on cast iron a series of tests was conducted, using as the iron melted scrapped car wheels, white iron and a good machinery pig iron of a variety of gray iron. A ferro-vanadium carrying a high percentage of carbon was selected because it melted at a lower temperature, and would be cheaper for the foundryman's use. The vanadium alloy contained: Vanadium, 14.67 per cent.; carbon, 6.36 per cent.; silicon, 0.18 per cent., and the rest ferro or pure iron. As cast iron is already high in carbon, and the silicon in this is too low to have an appreciable effect on the results, it is a good alloy for foundry purposes, even though the vanadium content is low. Varying proportions were added to the ladleful of molten metal, first in lump form and, as this did not give satisfaction with the small quantities of iron used at a time, the alloy was then powdered before using.

Inasmuch as vanadium, besides being a great strengthener, is also a powerful deoxidizing agent, and the increase in strength obtained by its use might be attributed to the purification of the iron only, a further series of tests was included in which the ladle was first treated with 80 per cent. ferro-manganese in sufficient quantity to add 0.5 per cent. of manganese and then the ferro-vanadium was added. In order to obtain some light on the deoxidizing power of vanadium, a set of tests was also made with burnt metal; the results of these are given herewith.

The test bars were of the regulation kind, as prescribed by the American Society for Testing Materials; namely, 1¼ inches round, cast on end and in dried sand molds. The cupola was a small one, especially made for the tests, with 22 inches diameter inside the lining and built into a corner of the experimenter's tower. The tuyeres were pretty close to the bottom, as but little iron was to be held at a time.

The test bars were dumped from the molds when cold, the sand was brushed off and then they were broken transversely on a 5000-pound Riehle testing machine.

*Abstract of a report to the American Foundrymen's Association.

### Vanadium in Burnt Cast Iron

Table 1 is of burnt gray iron (burnt grate bars, stove iron, etc.) and the average test of 5 pieces containing no vanadium was: Breaking strength, 1310 pounds; deflection, 0.090 inch, and modulus of rupture, 25,500 pounds per square inch. Vanadium in the lump was then added to this mixture in the ladle after tapping. The average strength taken from three test bars was changed to: Breaking strength, 2220 pounds; deflection, 0.100 inch, and modulus of rupture, 43,380 pounds per square inch. This was a gain of nearly 70 per cent. in the breaking strength and 11 per cent. in deflection.

Table 2 is of burnt white iron. The average of three test bars with no vanadium was: Breaking strength, 1440 pounds; deflection, 0.050 inch, and modulus of rupture, 28,170 pounds per square inch. To this was added 0.50 per cent. of manganese and 0.05 per cent. of lump vanadium, and the average of 12 test bars was: Breaking strength, 1910 pounds; deflection, 0.055 inch, and modulus of rupture, 37,400 pounds to the square inch. This was a gain of about 33 per cent. in the breaking strength and 10 per cent. in the deflection.

These two tables would indicate that vanadium renewed the life of the burnt metal and the renewal was not as great when manganese was added to the vanadium as when it was used alone.

### Vanadium in Gray Iron

In Table 3 melted pig iron with no scrap was used to make gray machinery iron. In these 0.05, 0.10 and 0.15 per cent. of vanadium was used in the lump and ground, as well as in combination with manganese with the following results.

The analysis of this iron before the vanadium or manganese was added was: Silicon, 2.72 per cent.; sulphur, 0.065 per cent.; phosphorus, 0.668 per cent.; manganese, 0.54 per cent. The average of five test bars of machinery gray iron (no scrap) with no vanadium was:

| Breaking strength in pounds. | Deflection in inches. | Modulus of rupture in pounds per square inch. |
|---|---|---|
| 1980 | 0.105 | 38,680 |

Average of five test bars with 0.05 per cent. of lump vanadium added was:

| | | |
|---|---|---|
| 2070 | 0.105 | 40,410 |

Average of 19 test bars with 0.10 per cent. of lump vanadium added was:

| | | |
|---|---|---|
| 2200 | 0.115 | 42,600 |

Average of four test bars, with 0.15 per cent. of lump vanadium added was:

| | | |
|---|---|---|
| 2740 | 0.130 | 53,750 |

Average of three test bars with 0.50 per cent. of manganese and no vanadium added was:

| | | |
|---|---|---|
| 1970 | 0.100 | 38,410 |

Average of five test bars with 0.05 per cent. of ground vanadium added was:

| | | |
|---|---|---|
| 1960 | 0.100 | 38,700 |

Average of four test bars with 0.50 per

cent. manganese and 0.05 per cent. ground vanadium added was:

2130 0.100 41,780

Average of five test bars with 0.10 per cent. of ground vanadium added was:

2372 0.090 46,320

Average of three test bars with 0.50 per cent. manganese and 0.10 per cent. ground vanadium added was:

2530 0.120 49,590

Average of five test bars with 0.15 per cent. of ground vanadium added was:

2360 0.100 46,070

This tabulation would indicate that the best results were obtained when vanadium was used in the percentage of 0.15 in the lump, as this showed an increase over the original metal of about 32 per cent. in the breaking strength, and 24 per cent. in the deflection. The test bars to which were added 0.50 per cent. manganese and 0.10 per cent. vanadium showed nearly as good results as this, and would form a cheaper mixture. The manganese seemed to aid the vanadium in increasing the strength, and did not retard it as in the burnt metals.

VANADIUM IN WHITE IRON

Table 4 gives the same series of tests in white iron by melting car wheels. No pig iron was used. The chemical analysis of the iron before adding the vanadium or manganese was: Silicon, 0.60 to 0.53 per cent.; sulphur, 0.122 to 0.138; phosphorus, 0.399 to 0.374; manganese, 0.38 to 0.44.

The average of these tests was as follows: The mixture was remelted car wheels, white, no pig iron. The average of five test bars with no vanadium added showed:

| Breaking strength in pounds. | Deflection in inches. | Modulus of rupture in pounds per square inch. |
|---|---|---|
| 1470 | 0.050 | 28,100 |

Average of five test bars with 0.05 per cent. of lump vanadium added was:

2190 0.050 41,570

Average of seven test bars with 0.10 per cent. of lump vanadium added was:

2050 0.050 39,750

Average of eight test bars with 0.15 per cent. of lump vanadium added was:

2264 0.060 44,480

Average of four test bars with 0.50 per cent. manganese and no vanadium added was:

2790 0.070 54,570

Average of six test bars with 0.05 per cent. of ground vanadium added was:

3020 0.060 59,030

Average of six test bars with 0.50 per cent. of manganese and 0.05 per cent. of ground vanadium added was:

2970 0.090 58,040

Average of three test bars with 0.10 per cent. of ground vanadium added was:

2800 0.055 54,890

Average of four test bars with 0.50 per cent. manganese and 0.10 per cent. of ground vanadium added was:

3030 0.090 59,220

Average of six test bars with 0.15 per cent. of ground vanadium added was:

2950 0.070 59,230

Average of six test bars with 0.50 per cent. manganese and 0.15 per cent. ground vanadium added was:

3920 0.095 76,650

This tabulation would tend to show that above 0.05 per cent. vanadium the manganese very materially aids the vanadium in increasing the strength of the iron, especially if it be white iron; the increase in strength of the last composition over that of the first being about 98 per cent. in the breaking strength, and 90 per cent. in the deflection, or nearly double.

With the small quantities tried the chances for irregular distribution were very great and a foundry with 5- or 10-ton ladles would give much better opportunities for getting accurate results. There is also the uncertainty of how much or how little of vanadium is oxidized. The best results with both manganese and vanadium show very little of the latter remaining.

To increase the breaking strength of gray cast iron from 2000 to 2500 pounds and of white cast iron from 1500 to 3900 pounds is sufficient to warrant further investigation on the part of every foundryman who has special problems in strength to master, and, therefore, this part of the investigations is given to the foundry public at this time rather than to wait for further tests still on the program.

If but a part of the resistance to deterioration found by adding vanadium to steel should be proven by service trials to exist in cast iron, then on the score of safety to human life alone, the metal belongs in every car wheel.

A still better method would be to use a more powerful deoxidizer than manganese and add vanadium on top of it.

## American Museum of Safety Devices

On the evening of Feb. 11 a meeting was held at Cooper Union, New York City under the auspices of the American Museum of Safety Devices, its subject being "Safety for American Life and Labor." The meeting was opened with a brief address by Bishop Potter, followed by an illustrated lecture by Dr. Wm. H. Tolman, descriptive of the principal museums of safety devices; notably those at Amsterdam, Berlin and Paris. Many safety devices applied to machines were shown, taken mainly from exhibits in the foreign museums. Among these were a number for woodworking machinery and machine tools. Other speakers were Hon. Carroll D. Wright, whose subject was "Economic Waste of Accidents"; Dr. Josiah Strong, who spoke on "Perils of Peace and War"; Rev. Percy S. Grant, "The Sacredness of Human Life," and Alfred J. Bolton, "Labor's Interest in the Prevention of Accidents."

Dr. Strong forcibly contrasted the enormous loss of life in industrial pursuits with the really large but comparatively small loss of life in our great wars.

The museum is arranging to hold a two months' exhibition at its headquarters, 231 West Thirty-ninth street, New York City, in the early spring.

## Orrin S. Werntz

Orrin S. Werntz, treasurer of the National-Acme Manufacturing Company since its organization, died February 6, having only reached his 32d year. Mr. Werntz has been in Cleveland since early in life, his first position being with the National Screw and Tack Company, holding that position until the organization of the National-Acme Manufacturing Company.

## Business Items

On and after February 22, the general offices of the International Steam Pump Company will be located at 115 Broadway, New York city.

Robert W. Hunt & Co. have established their St. Louis office, which is in charge of C. W. Gennet, Jr., at 1445 Syndicate Trust building. They have arranged to locate their chemical and cement laboratory in the same building.

## Trade Catalogs

Theodore Alteneder & Sons, Philadelphia, Penn. 1908 catalog of drawing instruments. Illustrated, 110 pages, 5½x8 inches, paper.

Boston Gear Works, Norfolk Downs, Mass. Catalog EI of gears, chains, sprockets, bearings, etc. Illustrated, 86 pages, 3½x6 inches, paper.

International Machine Tool Company, Indianapolis, Ind. Loose-leaf catalog giving description and specifications of the Libby full swing turret lathe.

De Laval Steam Turbine Company, Trenton, N. J. Bulletin No. 501, describing steam turbine machinery. Illustrated, 30 pages, 4½x7 inches, paper.

American Spiral Pipe Works, Chicago, Ill. Circular No. 21, illustrating and describing Taylor's spiral riveted pipe and forged steel flanges. 16 pages, 8x10 inches.

The Franklin Portable Crane and Hoist Company, Franklin, Penn. Catalog describing Franklin portable crane and hoist. Illustrated, 30 pages, 4x7½ inches, paper.

The Whitman & Barnes Manufacturing Company, Chicago, Ill. Catalog No. 66 of machinists' supplies, incuding Diamond twist drills, reamers, wrenches, etc. Illustrated, 112 pages, 3½x6 inches, paper.

Sprague Electric Company, 527 West Thirty-fourth street, New York. Bulletin No. 107 on continuous current direct-driven type S generators. Illustrated, 20 pages, 8x10½ inches. Bulletin No. 224, describing type D direct-current motors. Illustrated, 16 pages, 8x10½ inches. Bulletin No. 310, describing direct-current electric for ventilating fans and

blowers. Illustrated, 28 pages, 8x10½ inches. Bulletin No. 507 on flexible steel-armored hose. Illustrated, 16 pages, 8x10½ inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4544, illustrating and describing continuous current railway switchboards. 18 pages, 8x10½ inches. Bulletin No. 4558 on isolated plant switchboard panels with circuit breakers. Illustrated, 8 pages, 8x10½ inches. Bulletin No. 4563, illustrating and describing electric switch indicator type SI-104. Bulletin No. 4564 describing centrifugal air compressors for industrial air blast and exhauster service. Illustrated, 8 pages, 8x10½ inches.

## Manufacturers

The Illinois Show Case Company, Chicago, Ill., will erect a $40,000 factory.

The Apalachicola Northern railroad will build shops at Apalachicola, Fla., it is reported.

The plant of the Wholey Boiler Works, Providence, R. I., was destroyed by fire. Loss about $40,000.

The Belt Railway Commission, New Orleans, La., is having plans prepared for erection of roundhouse.

The Cannelton Sewer Pipe Company, Cannelton, Ind., capitalized at $50,000, proposes to erect a plant.

The car repair shop of the Alabama & Mississippi railroad at Vinegar Bend, Ala., was destroyed by fire, causing a loss of about $10,000.

The Rickersberg Brass Company, Cleveland, Ohio, has had plans prepared for a foundry and manufacturing plant to cost about $18,000.

Dewey Brothers, Goldsboro, N. C., have incorporated. Will make additions to the foundry, install new machine tools and electrical equipment.

C. H. Casebolt, with the Houston (Miss.) Cotton Oil Company, is interested in the organization of a company to establish a machine shop and foundry.

The Collins & Burgie Company, whose stove plant at Marengo, Ill., burned some time ago, will go to Pueblo, Colo., where a $150,000 plant will be erected.

The National Steel Casting Company, Guthrie, Okla., has been incorporated with $400,000 capital. H. W. Pentecost, of Guthrie, is one of the incorporators.

J. S. Strawn, of Avonmore, Penn., is looking for a location near Scottdale for the erection of a plant for the manufacture of coal-mine cars and mining supplies. Pittsburg and Kittanning parties are interested. The plant will cost about $100,000 and will include foundry, power house, forge shop, pressing department, etc.

# Want Advertisements

*Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.*

## Miscellaneous Wants

Caliper list free.E.G.Smith Co., Columbia, Pa.

Special machinery designed and built. Box 879, AMERICAN MACHINIST.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Draftsmen office agents wanted for new style tools. D. J. Kelsey, New Haven, Conn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machine Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Automatic machinery designed; special purpose machines; working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Inventions, novelties, ideas, etc., developed; special machines designed. Albert Pott, M. E., 23 Platt St., New York, and Waterbury, Conn.

If you have a copy of March 7, 1907 AMERICAN MACHINIST we'll give you fifteen cents for it. AMERICAN MACHINIST, 505 Pearl St., New York.

Wanted—Exclusive sales agency for New York territory for some standard machine, tool, steam, or electrical specialty. Box 868, AMERICAN MACHINIST.

Air, ammonia compressors, steam, gas engines, turbines, centrifugal pumps, special machinery designed; inventions developed. Box 814, AMERICAN MACHINIST.

Special machinery designed, new ideas developed to practical results; tell me the conditions you wish to improve and I will do the rest. Box 877, AMERICAN MACHINIST.

Tool manufacturer desires active partner with additional working capital; I have the trade, plant, some money and best bank references. Biddle, Box 123, AMER. MACHINIST.

Everyone interested in engineering, should send 50 cents for our "Introduction to the Science of Engineering," just out. The Mechanics Correspondence School, Box 455, Lockport, N. Y.

Wanted—Engineers in every city of 5000 or more inhabitants to sell and install our engine stop and signal system. For particulars write the Union Stop and Signal Co., 103 Bedford St., Boston, Mass.

Chauffers earn good wages; call and take a trial lesson at our garage; we do not wish you to enroll unless you like our method of instruction; booklet free. Automobile School, 754 South Broad St., Philadelphia.

Am willing to invest $10,000 to $25,000 in established going business needing additional capital and offering opportunity for active position to competent, high-grade man. George Bradley, 1 Union Square, New York.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

A firm of five mechanical engineers having well appointed offices in the largest office building in Chicago desire to connect with one or more eastern manufacturers with a view of representing them in Chicago; interested parties please address Rooms 452-453 Monadnock Block, Chicago.

## Situations Wanted

*Classification indicates present address of advertiser, nothing else.*

ILLINOIS

Draftsman, experienced in design of electrical and hydraulic apparatus, gas and steam engines. Box 869, AMER. MACHINIST.

Graduate mechanical engineer; 10 years' shop experience on general, electrical, automatic machinery and tools, and 3½ years designing; seeks responsible position in Chicago. Box 880, AMERICAN MACHINIST.

Assistant superintendent manufacturing plant 3 years; 5 years' previous experience in machine shop and drafting room; 32 years old; Yale graduate; member of A. S. M. E.; location, in or near Chicago. Box 732, AMERICAN MACHINIST.

INDIANA

Up-to-date executive, producer, organizer, systematic, experienced on machine tools, engines and mill repair will be ready to change soon. Box 871, AMERICAN MACHINIST.

MASSACHUSETTS

General foreman will be at liberty March 1; A-1 designer of tools, jigs, etc. Box 873, AMERICAN MACHINIST.

Position as superintendent or general foreman by an experienced mechanic; electrical machinery, air compressors, or machine tools. Box 878, AMERICAN MACHINIST.

Technical graduate (Cornell); nine years' experience; seeks position as engineer or representative; specialties, submarine cable and electrical instruments. Box 865, AM. MACH.

NEW JERSEY

Designer and draftsman, 28, married, technical education, inventive, executive ability, wishes change; 3 years' shop with pattern and foundry practice, 8 years' drafting experience on pumps, engines, special, general and textile machinery, transmission, steel construction. Box 876, AMERICAN MACHINIST.

NEW YORK

Designer and draftsman, 30, on different classes of machinery; technical graduate with shop experience. Box 875, AMER. MACHINIST.

Foreman toolmaker or master mechanic desires change; location Greater New York or vicinity; expert on tools, jigs, fixtures and special machine design; well up in modern shop; practical and successful handler of men; reasonable salary. Address Box 842, AMERICAN MACHINIST.

OHIO

Situation Wanted—Mechanical engineer; successful as a practical inventor and constructing engineer; experienced in gas, refrigeration, air, steam and hydraulic engineering, etc.; has invented and developed large variety of machinery now in general use; advertiser is a university graduate; a practical machinist; has had twenty years' experience in mechanical engineering; is of course now fully occupied, but desires to make a change for good reasons, and invites correspondence; only the highest class position in the engineering sense is desired; any location satisfactory. Box 847, AMERICAN MACHINIST.

PENNSYLVANIA

Draftsman; practical machine designer and machinist desires permanent position; will locate anywhere. Box 874, AMER. MACH.

Mechanical engineer and draftsman; college graduate; all-around man; 8 years' experience in designing of machinery and plants; desires to change present position. Box 864, AMERICAN MACHINIST.

Engineer skilled in designing and constructing machinery for rapid production desires position of responsibility with concern manufacturing duplicate parts in large quantities. Box 857, AMERICAN MACHINIST.

FOREIGN

Mechanical erector desires engagement with manufacturing concern to erect machines in South America; speaks English, German, Italian and Spanish; experience in Germany, and 4 years in America; native of Buenos Ayres; further information furnished. Box 870, AMERICAN MACHINIST.

Master mechanic; American; age 37; responsible man with large and varied experience manufacturing, erecting and maintaining; successful in producing high grade work at lowest cost; at liberty July 1; Pacific Coast States only; state salary. B. Nilius, Master Mechanic, Rio Blanco, Peru, via Lima.

## Help Wanted

*Classication indicates present address of advertiser, nothing else.*

MASSACHUSETTS

Wanted—As storekeeper, receiving and shipping clerk; a capable man who has had similar experience. Cell Drier Machine Co., Taunton, Mass.

Wanted—First-class foreman for machine work on brass castings; also foreman for machine shop on general and small work. Box 872, AMERICAN MACHINIST.

MISSOURI

Superintendent wanted; experienced in

building gas engines; good mechanic executive; one who can invest. Miners Gas Engine and Mfg. Co., Joplin, Mo.

NEW JERSEY

Wanted—Boiler room foreman capable of running economically 4000 horse-power Climax boilers; preference given to one able and willing to take salary out of saving shown over present cost of operation; permanent position to right man; give age, education and experience. "New Jersey," Box 831, AMERICAN MACHINIST.

NEW YORK

Wanted—Mechanical draftsman; one who has had some experience at designing; must be a good detailer and copyist and willing to do that class of work; technical graduate preferred; state age, salary, etc. "Detailer," care AMERICAN MACHINIST.

Experienced designer of special machinery; must be competent to estimate on work and to solicit new business when required; exceptionally good opportunity and future for right man. Address with full particulars as to experience, age, nationality, references and salary expected. Box 867, AMER. MACH.

General foreman for shop employing 50 to 75 men on special machinery, machine tools, and general jobbing; must be first-class mechanic and good executive, familiar with modern shop methods, systematic, and have the right personality and push to produce results at minimum cost; give full particulars as to experience, age, nationality, salary expected and references. Box 866, AM. MACH.

Superintendent with experience and good executive ability, capable of taking full charge of the manufacturing end of a modern plant employing 250 men in the manufacture of a line of A-1 machine tools; location, a pleasant town of 10,000 inhabitants, moderate rents, etc.; this is a good opportunity for the right man; state age, experience and salary expected, with references. Address "Manufacturer," AMERICAN MACHINIST.

Wanted—managing foreman; young man who is successfully filling similar position, but is desirous of advancing, and can handle 300 men from castings to finished product on plain and high speed engines 3 to 300 horse-power, pumps and similar work; state in full, length of time each position, responsibilities, results, references and salary wanted to start; excellent opportunity for a young man of executive ability for advancement. Box 974, Buffalo, N. Y.

PENNSYLVANIA

Wanted—A general foreman, one who is experienced in all branches of engine work; applicant must be a hustler, thoroughly familiar with modern shop methods, able to handle men and show a clean record from past employers. Riverside Engine Company, Oil City, Pa.

Engineer and draftsman with thorough experience in the designing of air compressors and air compressing machinery in general; good position with chance to advance for the right man; first letter must give full details as to past experience along this line, age and salary expected, also present employment; all replies treated confidentially. "Compressors," AMERICAN MACHINIST.

FOREIGN

Wanted—A chief constructing engineer for high tension switches by a large German firm, manufacturing electrical supplies; engineers who have been engaged for a considerable time in managing construction work in this line and who speak and write the German language fluently, are requested to address applications, with a brief description of their previous experiences, statement of references, time when they will be able to enter upon their duties and expectations as to salary, to J. Z. 9861, care Rudolf Mosse, Annoncen-Expedition, Berlin, S. W.

# For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

For Sale—Two brand new Browne & Sharp automatic screw machines, one No. 0 and one No. 00, including all attachments for same. Rockford Automobile & Engine Co., Rockford, Ill.

Patent for sale; an inexpensive bevel and mitre gear cutting attachment for use with a shaper; will unquestionably do a class of work which has heretofore been possible only with very high priced special machines. Address W. W. Clippinger, 80 Atlas Bank Bldg., Cincinnati, Ohio.

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*See Grinding Wheels.*

**Arbor Presses**

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**Arbors**

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**Belt Fasteners**

Bristol Co., Waterbury, Conn.

**Belt Filler**

Schieren Co., Chas., A., New York.
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**Belt Lacing Machine**

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

**Belt Shifters**

The L. & D. Co., Boston, Mass.

**Belting, Leather**

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**Bending Machinery, Hydraulic**

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

**Bending Machinery, Plate**

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

**Bending Machinery, Power**

Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

**Bending Tools, Hand**

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

**Blanks, Nut and Screw**

Whitman & Barnes Mfg. Co., Chicago, Ill.

**Blocks, Chains**

*See Hoists, Hand*

**Blocks, Die**

Nicholson & Co., W. H., Wilkes-Barre, Pa.

**Blowers**

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

**Blue Print Machines**

General Electric Co., New York.

**Blue Print Paper**

Keuffel & Esser Co., New York.

**Bolt and Nut Machinery**

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Milton Mfg. Co., Milton, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National-Acme Mfg. Co., Cleveland, O.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York

**Bolt and Nut Machinery** —*Continued.*

Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

**Bolt Heads**

Lang Co., G. R., Meadville, Pa.

**Bolts and Nuts**

Cleveland Cap Screw Co., Cleveland, O.
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

**Bone for Case Hardening**

Rogers & Hubbard Co., Middletown, Conn.

**Books, Technical**

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
Piers, Frank, Phila., Pa.
Sames, Chas. M., Jersey City, N. J.

**Boosters**

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Boring and Drilling Machines, Horizontal**

Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.

**Boring and Drilling Machines, Horizontal**—*Cont.*

Gisholt Mach. Co., Madison, Wis.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Machine Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

**Boring and Turning Mills, Vertical**

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Niles-Bement-Pond Co, New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

**Boring Tools**

Armstrong Bros. Tool Co., Chicago, Ill.

**Boxes, Tote**

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

**Box Tools, Roughing**

Bardons & Oliver, Cleveland, O.

**Brackets, Lamp**

Standard Welding Co., Cleveland, Ohio.

**Brazing**

Industrial Oxygen Co., New York.

**Broaching Machines**

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

**Bulldozers**

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

**Cabinets, Tool**

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

**Calipers**

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

**Cams**

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

**Carborundum**

*See Grinding Wheels.*

**Carborundum Paper and Cloth**

Carborundum Co., Niagara Falls, N. Y.

**Case-Hardening**

Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

**Cast Iron Brazing**

Industrial Oxygen Co., New York.

**Castings, Brass and Bronze**

Lumen Bearing Co., Buffalo, N. Y.
Neptune Meter Co., Long Island City, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

**Castings, Die Molded**

Franklin Mfg. Co., H. H., Syracuse, N. Y.

**Castings, Iron**

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.

**Castings, Steel**

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Carpenter Steel Co., Reading, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry & Mach. Co., Ansonia, Conn.

**Cement, Cast Steel**

Clark Cast Steel Cement Co., Shelton, Conn.

**Centering Machines**

Hendey Mach. Co., Torrington, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

**Centers, Planer**

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

**Chains, Driving**

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

**Chisels, Cold**

Whitman & Barnes Mfg. Co., Chicago, Ill.

**Chucking Machines**

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

**Chucks, Drill**

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

**Chucks, Lathe**

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.

**Chucks, Lathe**—*Continued.*

Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

**Chucks, Planer**

Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

**Chucks, Split**

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

**Circuit Breakers**

Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Clamps**

Billings & Spencer Co., Hartford, Conn.
Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

**Clutches, Friction**

Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.

**Clutches, Magnetic**

Electric Controller & Supply Co., Cleveland, O.

**Coal Handling Machinery**

Link-Belt Co., Philadelphia, Pa.

**Coils**

Standard Welding Co., Cleveland, Ohio.

**Collets and Attachments, Spring**

Adjustable Collet Co., Cleveland, Ohio.

**Compound, Core**

Obermayer Co., S., Cincinnati, O.

**Compound, Pipe Joint**

Dixon Crucible Co., Joseph, Jersey City, N. J.

**Compressors, Air**

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

**Compressors, Gas**

Blaisdell Machinery Co., Bradford, Pa.

**Cones, Friction**

Evans Friction Cone Co., Newton Centre, Mass.

**Connecting Rods and Straps**

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

**Contract Work**

Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Machine Co., Taunton, Mass.
Dietz Machine Works, Phila., Pa.
Ingle Machine Co., Rochester, N. Y.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

**Controllers and Starters, Electric Motor**

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Conveyors, Automatic**

Link-Belt Co., Philadelphia, Pa.

**Coping Machines**

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

**Corundum**

*See Grinding Wheels.*

**Cotters**

Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

**Counterbores**

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

**Counters, Machinery**

Veeder Mfg. Co., Hartford, Ct.

**Countershafts**

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

**Countershafts, Friction**

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

**Countershafts, Speed Changing**

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

**Counting and Printing Wheels**

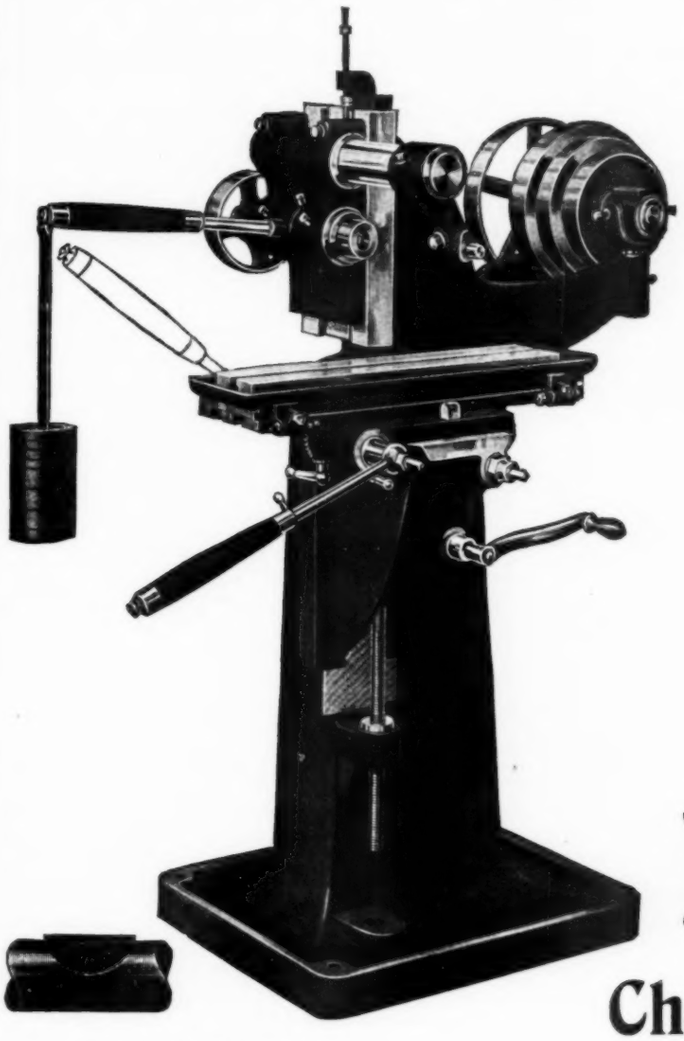
Franklin Mfg. Co., H. H., Syracuse, N. Y.

**Couplers, Hose**

Ingersoll-Rand Co., New York.

**Couplings, Shaft**

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.



THOUSANDS of milling operations are being made on expensive power(feed) milling machines that could be done quicker and to better advantage on this Hand and Weight (feed) Miller, costing half the money.

It also cuts Key Seats automatically for the Woodruff Patent System of Keying.

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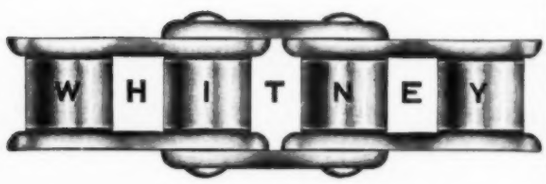


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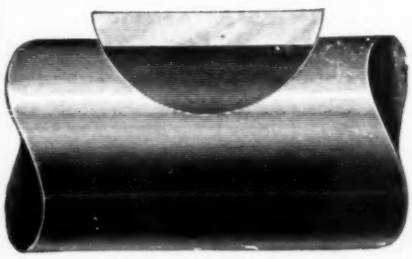

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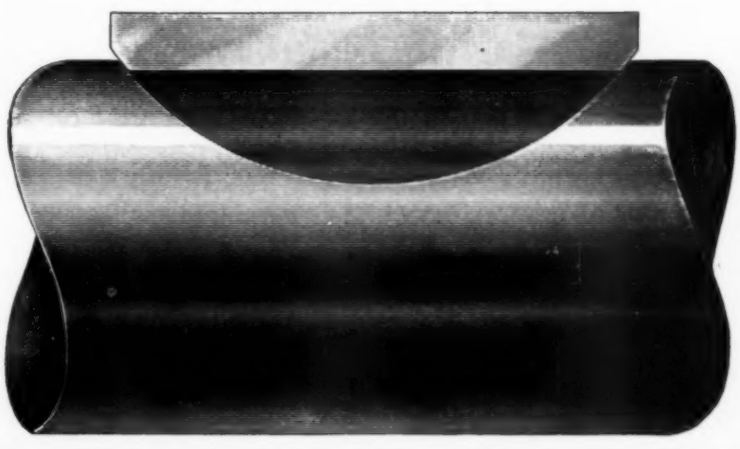

**The Whitney Mfg. Co.,**

**Hartford, Conn., U. S. A.**

**Couplings, Shaft**—*Continued.*
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

**Cranes**
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co.. New York.
Yale & Towne Mfg. Co. New York.

**Crank Pin Turning Machines**
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

**Crank Shafts**
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

**Crucibles**
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

**Crushers**
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

**Cupolas, and Ladles, Foundry**
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

**Cups and Covers, Oil**
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co, Cincinnati, O.
Winkley Co., Detroit, Mich.

**Cups, Grease**
Lunkenheimer Co., Cincinnati, O.

**Cutters, Milling**
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros. Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

**Cutting-off Machines**
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Huribut-Rogers Mach. Co., South Sudbury, Mass.

**Cutting-off Machines**—*Cont.*
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

**Cutting-off Tools**
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

**Diamond Tools**
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

**Dies, Sheet Metal**
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, O.
Manville Bros. Co., Waterbury, Conn.
Risdon Tool Works, Waterbury, Conn.

**Dies, Sub-Press**
Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

**Dies, Threading, Opening**
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

**Dowel Pins**
Winkley Co., Hartford, Conn.

**Drawing Boards and Tables**
Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.

**Drawing Materials**
Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

**Drafting Machines**
Universal Drafting Mach. Co., Cleveland, O.

**Drilling Machines, Bench**
American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

**Drilling Machines, Boiler**
American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.

**Drilling Machines, Boiler**—*Continued.*
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

**Drilling Machines, Electric**
Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.

**Drilling Machines, Multiple Spindle**
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

**Drilling Machines, Portable**
Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

**Drilling Machines, Radial**
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

**Drilling Machines, Turret**
Niles-Bement-Pond Co., New York.

**Drilling Machines, Upright**
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.

**Drilling Machines, Upright**—*Continued.*
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

**Drills, Center**
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

**Drills, Hand**
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

**Drills, Pneumatic**
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton -Air Compressor Works, New York.

**Drills, Rail**
Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

**Drills, Ratchet**
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O

**Drills, Rock**
Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

**Drill Speeder**
Graham Mfg. Co., Providence, R. I.

**Drying Apparatus**
Sturtevant Co., B. F., Hyde Park, Mass.

# Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

No. 13

## UNIVERSAL *and* TOOL GRINDING MACHINE.

Capacity: Centers take 24½" in length; swing 8" in diameter.

This machine is designed to meet the requirements of the tool room in the grinding of all varieties of cutters and in addition, cylindrical grinding, either straight or taper can be done. Attachments are furnished when desired that fit the machine for internal and surface grinding, as well as for the grinding of convex or concave cutters whose teeth are not formed and require to be ground on the periphery. A machine of this type then is especially suitable to the needs of the small shop where the volume of work does not warrant the installation of grinding machines of different kinds to accommodate the variety of work that can be ground upon this machine.

**Dynamos**

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Electrical Supplies**

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Electrically Driven Tools and Machinery**

American Tool Wks. Co., Cin., O.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

**Elevators**

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

**Emery Wheels**

*See Grinding Wheels.*

**Emery Wheel Dressers**

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephen Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

**Enclosures, Tool-room**

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

**Engineering Appliances**

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

**Engineers, Consulting and Architect**

Thompson, Hugh L., Waterbury, Conn.

**Engineers, Mechanical and Electrical**

Crocker - Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

**Engines, Gas and Gasolene**

Automatic Mach. Co., Bridgeport, Conn.

**Engines, Gas and Gasolene** *—Continued.*

Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.

**Engines, Motor**

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

**Engines, Steam**

Sturtevant Co., B. F., Hyde Park, Mass.

**Engraving Machinery**

Gorton Mach. Co., Geo., Racine, Wis.

**Exhaust Heads**

Sturtevant Co., B. F., Hyde Park, Mass.

**Exhibition, Machinery**

Philadelphia Bourse, Phila., Pa.

**Expanders, Tube**

Nicholson & Co., W. H., Wilkes-Barre, Pa.

**Eyelet Machinery**

Manville Bros. Co., Waterbury, Conn.

**Factory Equipment**

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

**Fans, Electric**

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

**Fans, Exhaust**

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

**Files and Rasps**

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.
Simonds File Co., Fitchburg, Mass.

**Filler, Iron**

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

**Filing Machines**

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

**Flexible Shafts**

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

**Forges**

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

**Forgings, Drop**

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co, Hartford, Conn.
Bullard Auto. Wrench Co., Providence, R. I.

**Forgings, Drop**—*Continued.*

Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

**Forgings, Hydraulic**

Bethlehem Steel Co., So. Bethlehem, Pa.

**Forgings, Steel**

Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Tindel-Morris Co., Eddystone, Pa.

**Foundry Furnishings**

Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

**Furnaces, Annealing and Tempering**

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co, Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

**Furnaces, Enameling**

American Gas Furnace Co., New York.

**Furnaces, Gas**

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

**Furnaces, Melting**

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

**Furnaces, Oil**

Tate, Jones & Co., Pittsburg, Pa.

**Furniture, Machine Shop**

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

**Gages, Recording**

Bristol Co., Waterbury, Conn.

**Gages, Standard**

Ames & Co., B. C., Waltham, Mass.
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

**Gages, Steam**

Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.

**Gear Cutting Machinery**

Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.

**Gear Cutting Machinery** *—Continued.*

Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waltham Machine Works, Waltham, Mass.
Whiton Machine Co., D. E., New London, Conn.

**Gear Testing Machinery**

Gisholt Mach. Co., Madison, Wis.

**Gears, Cut**

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

**Gears, Molded**

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

**Gears, Rawhide**

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.